IBM Customer Engineering

Manual of Instruction

729 II, III, IV Tape Units

729-II, 729-III, 729-IV Magnetic Tape Units

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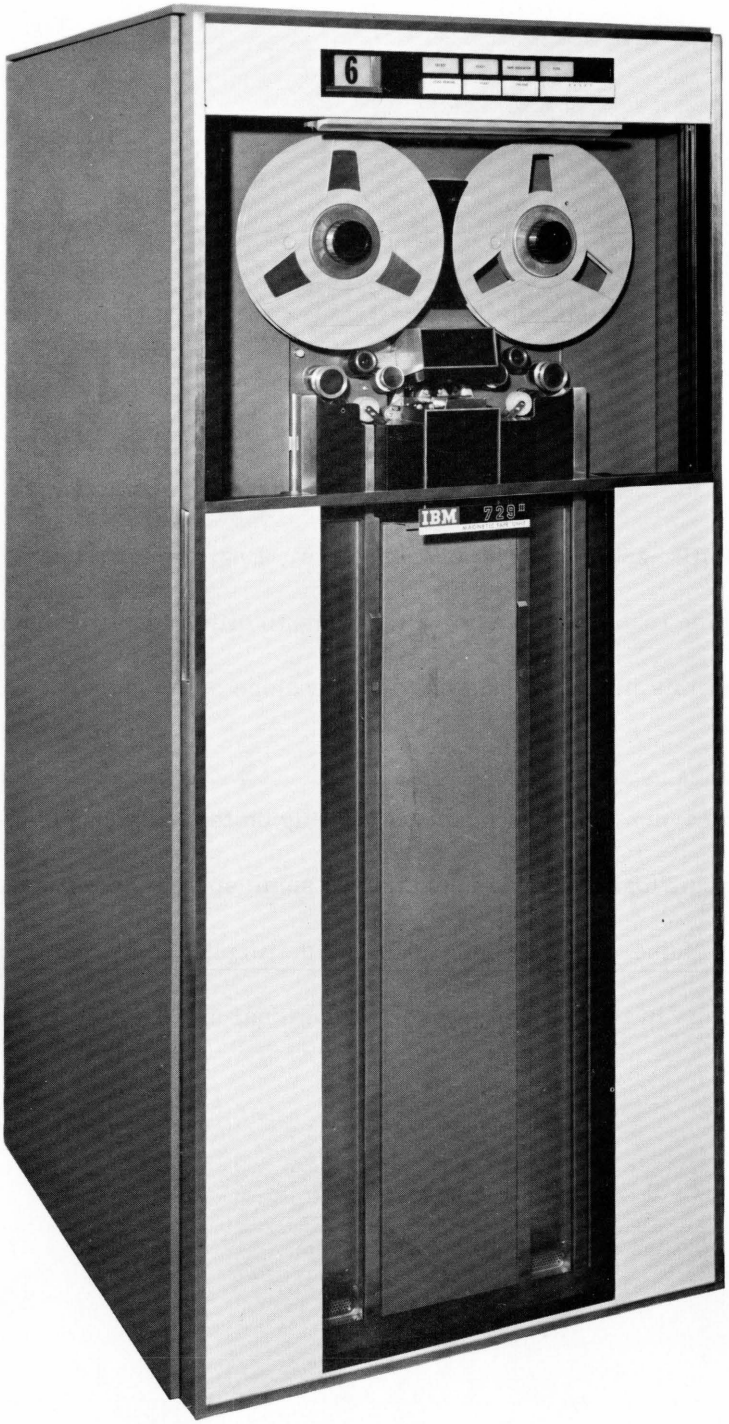
FOREWORD

This manual has been prepared for teaching purposes and as an aid for learning the IBM 729 II, III, and IV Magnetic Tape Units. Engineering changes may alter logic and machine functions, causing a tape unit to differ from the descriptions presented here; this manual should not be used alone as a reference manual or servicing aid.

The manual covers theory of magnetic writing on tape, mechanical operating principles, circuit logic, and the operation of some special component circuits in the tape units. Names of electronic lines are distinguished by quotation marks. Systems diagrams in this manual are for educational use only.



IBM 729 II, III, IV, TAPE UNIT

1.0.00 INTRODUCTION

THE IBM 729 II, III, and IV Magnetic Tape Units are used with other data processing equipment as input-output devices. These tape units are mechanically and electrically similar except for the following:

	729 II	729 III	729 IV
Tape Speed	75 inches/sec	112.5 inches/sec	112.5 inches/sec
Bit Density	200	555	555
Write Pulse Frequency	67.2 usec	16 usec	16 usec
Signal Levels	Transistor levels input, output, and internally	Vacuum tube levels input and output; transistor levels internally	Transistor levels input, output, and internally

The tape units are controlled externally and have self-contained, automatic, and manual functions. AC voltage is obtained externally while all DC voltages for relay and electronic circuits are developed within the tape unit.

Functions of the tape unit are:

Writing
Reading
Backspacing
Rewinding

The mechanism provides for:

Easy loading and unloading
Fast rewind of tape
Recognizing the physical ends of tape and tape breaks

2.0.00 MACHINE SPECIFICATIONS

2.1.00 TAPE UNIT

1. Weight: 1000 pounds
2. Dimensions: 33" long x 29" wide x 69" high
3. Vacuum: approximately 16" water
4. Voltage: 208v, three-phase, 60 cycles per sec
5. Current: 6.4 amps approx.
6. Wattage: 1.34 KVA

2.2.00 TAPE -- ACETATE AND MYLAR*

1. Width: 0.498 ± .002 inch
2. Total thickness: .0022 (+ .003 - .004) inch
3. Base thickness: .0015 ± 10% inch
4. Ferromagnetic material and binder: .0006 inch
5. Tensile strength (minimum)
   Mylar: 12 pounds
   Acetate: 8 pounds

The ferromagnetic material, or magnetic oxide, is the physical medium on which information is stored.

Magnetic tape used in data processing is of the highest quality. Each reel of tape is tested by IBM before it is shipped to help eliminate conditions leading to an error either in storing or reading information when using IBM magnetic tape equipment.

2.3.00 HUMIDITY CONSIDERATIONS

Cellulose acetate is dimensionally unstable with respect to relative humidity. Between 20 percent and 80 percent relative humidity, tape width can change as much as .0069 inch. When relative humidity varies over a wide range, resulting width variations present a problem of storing and using the tape.

Mylar is more stable. Between 20 percent and 90 percent relative humidity, tape width varies .0023 inch or 1/3 the variation of cellulose acetate tape.

Proper tape storage is, therefore, necessary to obtain satisfactory performance. If tape is stored where the humidity ranges between 40 percent to 60 percent relative humidity, design tolerances are maintained. If tape is stored in an atmosphere outside the specifications, the probability of errors increases.

Temperature variations are secondary in comparison to humidity. If the tape is stored at about 70°F, no departure from the specified width should be observed. See Section 5.0.00.

* Trademark of E. I. du Pont de Nemours & Co. (Inc.)

2.4.00 TAPE CAPACITY

Information may be written in any of seven tracks across the face of the tape; each track is independent of every other track. The tracks appear similar to Figure 2.4-1.

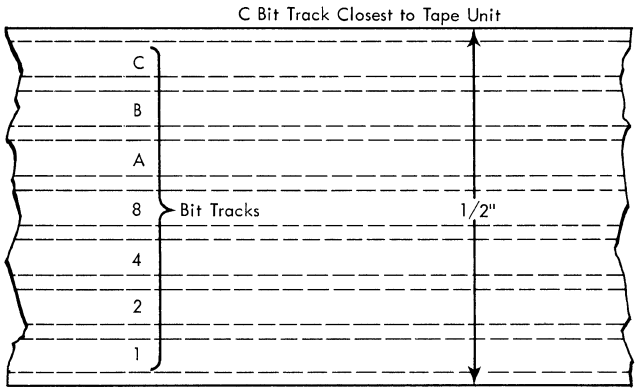


FIGURE 2.4-1. BIT TRACKS ON TAPE

As tape is fed through the tape unit, the writing of characters (bits) is controlled by write pulses generated in the external source. Tape speed, number of bits per inch, and frequency of write pulses for the 729 II, III, and IV are given in Section 1.0.00.

Information is placed on tape in any desired bit configuration. Configuration and interpretation are controlled by the external control.

Tape capacity is greatly affected by the inter-record gap (the distance required to stop and start the tape). About 1/4 inch is required to stop tape; about 3/16 inch is required to get tape up to speed. (For accuracy, a write delay is built into the external control source, so total tape travel before writing is about 1/2 inch.) The combined distance required to stop and start writing is 3/4 inch.

Through good programming, records may be grouped to conserve space on tape.

3.0.00 STORING INFORMATION

3.1.00 MAGNETIC THEORY

A magnetic material can be polarized or partially polarized under the influence of a magnetic field. For every magnetic material, a B-H curve (Figure 3.1-1) can be plotted. The B-H curve shows the resultant flux densities (B) when the material is placed in the influence of a varying magnetizing force. If a magnetizing force of ampere-turns (H) is slowly increased in the positive direction, the resultant flux density in a magnetic medium at first increases rapidly, then slowly attains a steady value of flux.

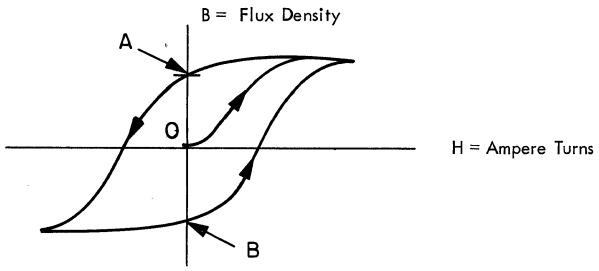


FIGURE 3.1-1. B-H CURVE

The phenomenon of attaining a steady value of flux density is called saturation of the magnetic material. When the ampere-turns are slowly reduced, flux density also decreases, but at a different rate. This is the hysteresis effect. When the magnetizing force is again zero, the flux density is not equal to zero, but is equal to some positive value (point A). The amount of magnetic flux remaining (distance A-O) when H is equal to zero is the residual magnetism in the material.

If: (1) the ampere-turns are reversed by a reversal in circuit, (2) current magnitude is increased in the negative direction until saturation again is reached, and (3) current magnitude again is returned to zero, a negative resultant flux remains (point B). Using suitable circuit techniques, a flux pattern of either positive or negative polarity can be impressed on a magnetic material.

Figure 3.1-2 shows how information is stored on magnetic tape. The magnetic circuit consists of a laminated core, an air gap, a mylar shim, and magnetic oxide on the tape. The core is mu metal, which has a high permeability and low retentivity. Permeability is the ability of a magnetic material to conduct lines of flux; it is designated by the Greek letter Mu (u) and is numerically equal to the ratio of the flux density to the magnetizing force ($u = \frac{B}{H}$); the mu of air = 1. Retentivity is the capacity of a magnetic material to retain magnetism after the magnetizing force is removed. The oxide has a low permeability of about 7-9 and a high retentivity. The half-mil gap causes the magnetic lines of flux to diverge away from the head and into the magnetic oxide on the tape. The shim prevents loose oxide from filling the gap.

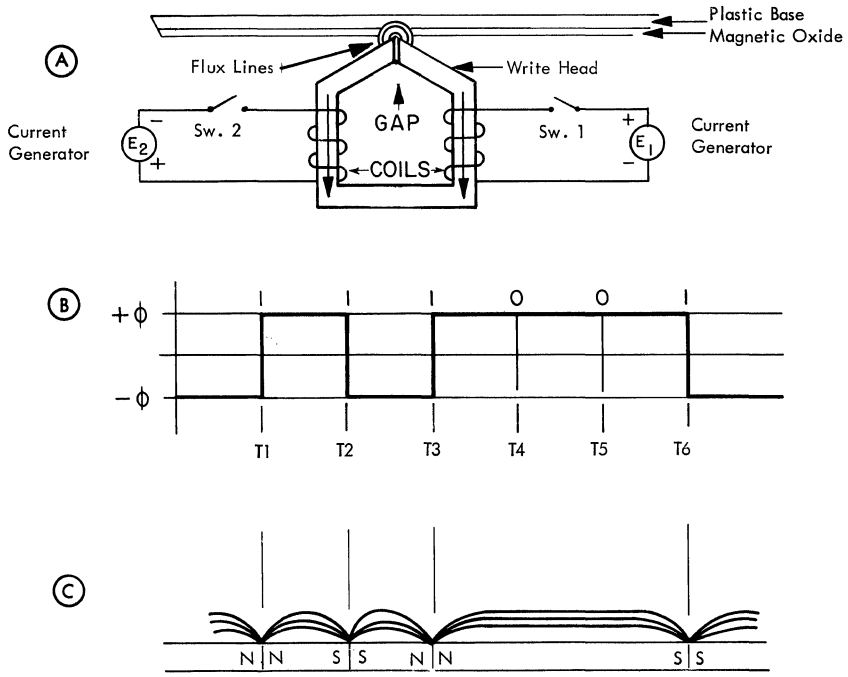


FIGURE 3.1.-2. METHOD OF WRITING ON MAGNETIC TAPE (NRZI SYSTEM)

3.2.00 NRZI SYSTEM (NONRETURN TO ZERO IBM)

3.2.01 Introduction

The NRZI system of recording binary information is one in which tape is continuously saturated in either the positive or negative direction. Within a given period of time, a change in saturation polarity is called a "one", and no change is called a "zero". The process of storing information is called writing and the process of detecting stored information is called reading.

3.2.02 Operation

When switch 1 (Figure 3.1-2A) is closed at time T1, current generator E_1 causes current to flow through the coil; a flux path is set up as shown by the arrows. Because this flux path extends into the magnetic oxide on the tape, the oxide particles are magnetized in the direction of the flux path. If the tape is moving, all the area passing over the write head is magnetized in the same direction.

If, at time T2, switch 2 is closed and switch 1 is open, current generator E_2 causes current to flow through the opposite write coil. This causes the flux path to be reversed and the oxide particles to magnetize accordingly. Because the switching time is very short, the tape moves only a minute distance during the reversal. This process constitutes writing a one bit on the tape. If, at time T3, the flux in the head is again reversed, another binary one is written. If, at time T4, no reversal is made, a binary zero is written. Thus, if a reversal in flux is made at any time, a binary one is written; if no reversal is made, a binary zero is written.

The magnetic material on the tape can be considered as being a series of tiny bar magnets placed end to end. Where the change in flux occurs, there are like poles; where no change occurs, there appears to be a long magnet (Figure 3.1-2C).

Reading a binary one also makes use of this principle; a voltage is induced in a coil whenever there is change of the flux cutting the turns of the read coil. (This principle can be stated in the fundamental equation: $e = - N d\phi / dt$.) When a reversal of flux pattern is encountered as the tape is passed over the head, a voltage pulse is induced in the windings. This voltage is routed to amplifier circuits.

A binary one is sensed as a voltage pulse at the terminals of the coil. (This pulse is produced by a flux change in either direction). The absence of a pulse (no change in flux) indicates a binary zero.

The IBM 729 II, III, and IV tape units employ a two gap head which eliminates the need for a separate erase head. With the present system erasing is accomplished by writing a new record over the old one.

The advantages of the NRZI system are:

High inherent density.	Binary ones can be written closer together than in a pulse system.
High output when reading.	Maximum change of flux occurs from one saturation level to the other.
Simplified erasing technique.	Erasing to saturation is simpler than erasing to zero flux. (Writing a new record erases the old record).

4.0.00 PHYSICAL DESCRIPTION

THE IBM 729 Magnetic Tape Unit is built on a frame. The reels, vacuum columns, two-gap read-write head, prolays, and capstans are on the front of the frame. The manual control keys and lights are at the top of the unit. Figures 4.0-1, 4.0-2, 4.0-3, and 4.0-4 show the tape unit without covers.

4.1.00 TAPE MOTION

Tape is transported from the file reel past the read-write head to the machine reel by a drive capstan and prolay idler. It would be impossible to start and stop the tape efficiently under control of the reels because the reel drives are relatively sluggish.

Vacuum columns below the reels provide buffer storage areas. A loop of tape is retained in each of these columns. As tape is drawn from one column, it is replenished by the associated reel. As tape is pushed into the opposite column, the associated reel winds the tape. The control of reel motion and the reel drive is discussed later. Figure 4.1-1 shows the path of tape through the 729 tape unit.

Forward Direction

The right and left drive capstans turn continuously in the direction shown. To move tape from left to right, the right prolay idler is pivoted to the right, squeezing the tape between the prolay idler and the right drive capstan. The left prolay idler is pivoted into a neutral position so it does not obstruct tape movement.

Backward Direction

To move tape from right to left, the left prolay idler is pivoted to the left, causing the tape to be squeezed between the prolay idler and the left drive capstan. The right prolay idler pivots to a neutral position.

Stop

To stop tape motion, the prolay idlers pivot toward the stop capstans, causing the tape to be squeezed between either the right or left prolay idler and the right or left stop capstan, respectively. If tape is being drawn from left to right, (forward direction) it is stopped by the left stop capstan. If the tape is being drawn from right to left, (reverse direction), it is stopped by the right stop capstan.

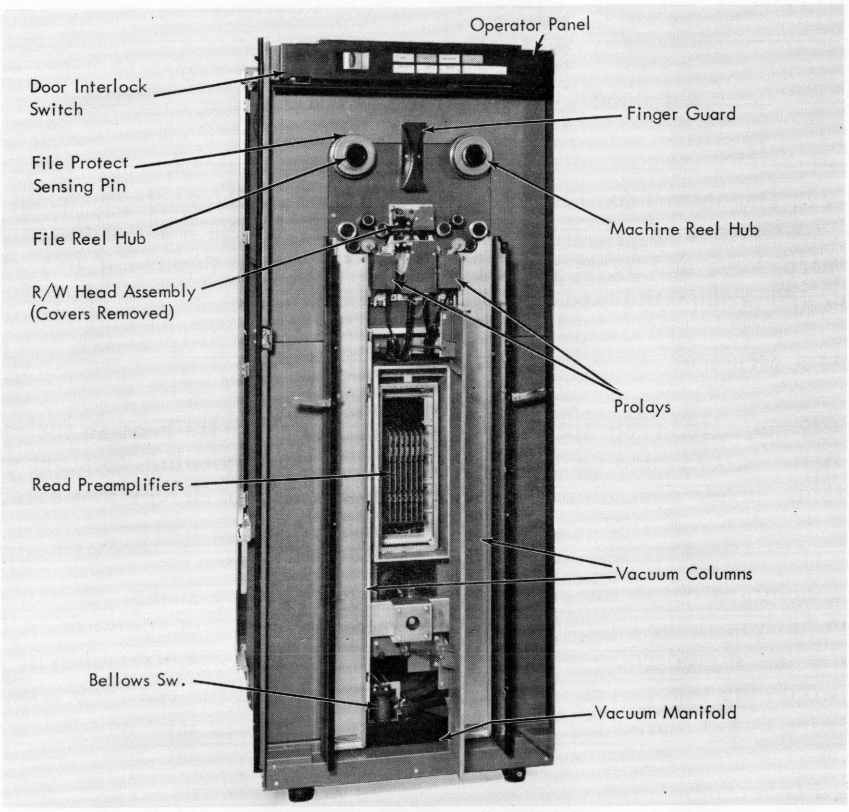


FIGURE 4.0-1. TAPE UNIT FRONT

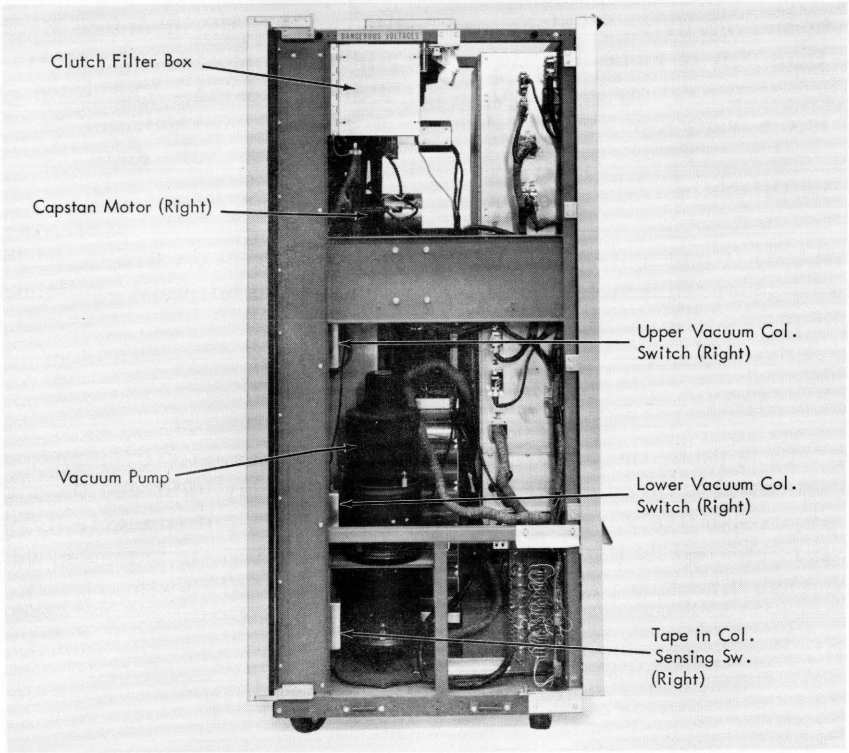


FIGURE 4.0-2. TAPE UNIT RIGHT

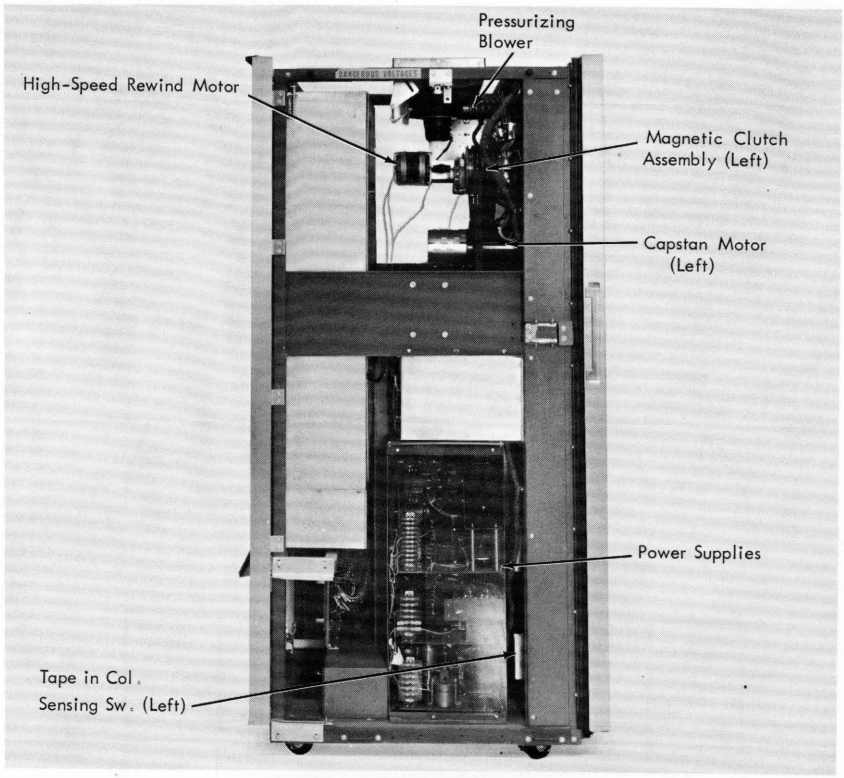


FIGURE 4.0-3. TAPE UNIT LEFT

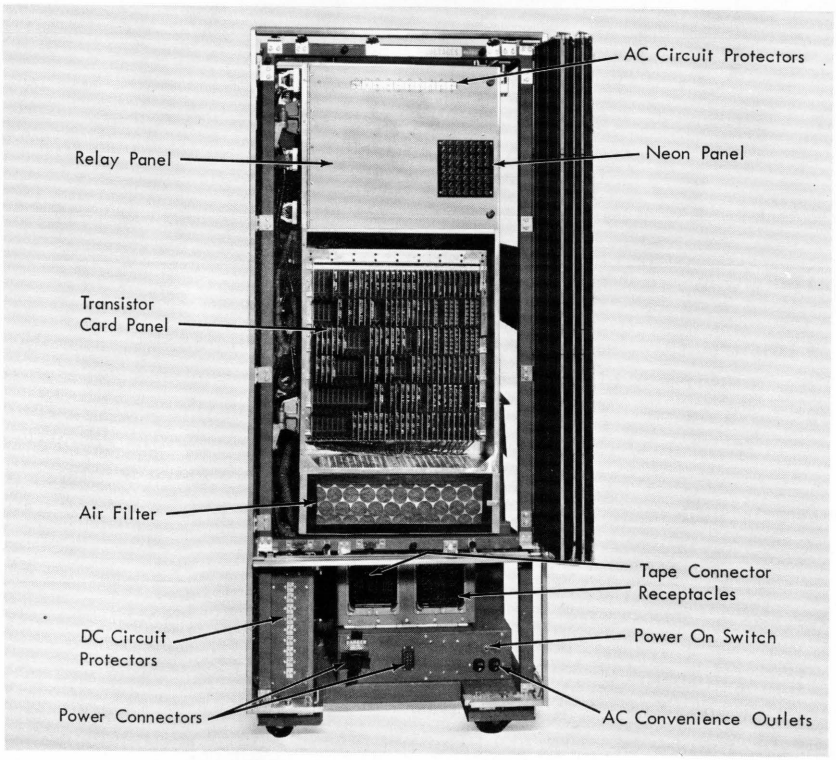


FIGURE 4.0-4. TAPE UNIT REAR

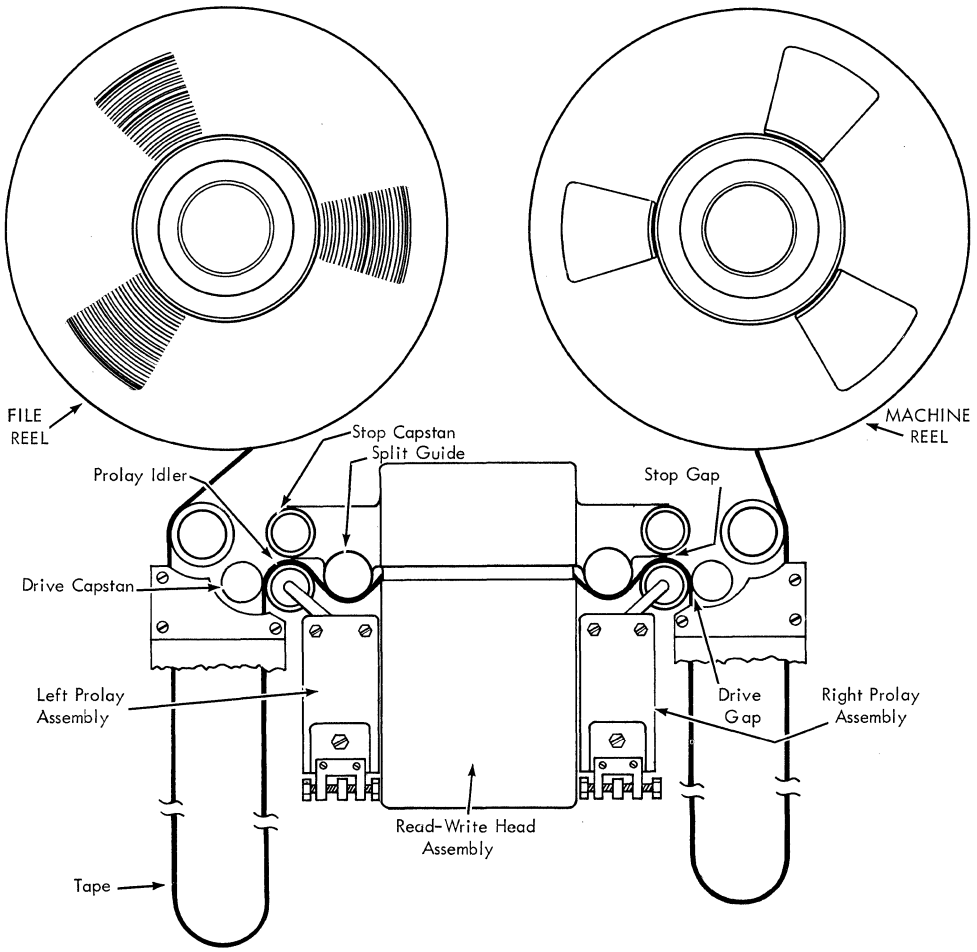


FIGURE 4.1-1. PATH OF TAPE THROUGH IBM 729 MAGNETIC TAPE UNIT

4.2.00 PROLAY ASSEMBLY

4.2.01 Introduction

Motion is imparted to the prolay idler by a prolay. Basically, a prolay consists of three sets of electro-magnets and an armature. The magnets are arranged so the armature can assume one of three positions depending on which set of magnets is energized. The motion of the prolay armature is transferred to the prolay idler and can cause it to move against the stop capstan or the drive capstan, or to a neutral position between the two capstans. Figure 4.2-1 shows a prolay energized in stop status.

4.2.02 Operation

Prolay operation follows: The armature is pivoted at the lower end of an arm. The prolay idler is attached to the upper end of the arm. The arm is pivoted as shown. With this arrangement a movement of the prolay armature will produce movement of the arm about its pivot point, causing the idler to change its position. In Figure 4.2-1, it can be seen that energizing the stop magnets moves the prolay armature to the right, causing counterclockwise movement of the arm about its pivot. This causes the prolay idler to squeeze tape against the stop capstan.

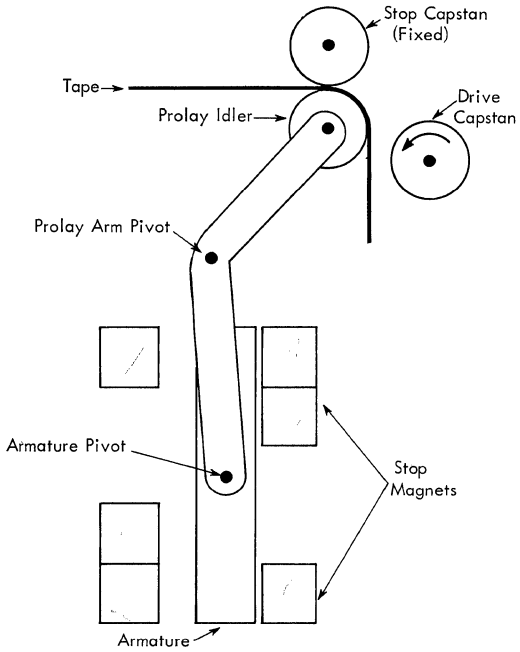


FIGURE 4.2-1. RIGHT PROLAY WITH STOP MAGNETS ENERGIZED

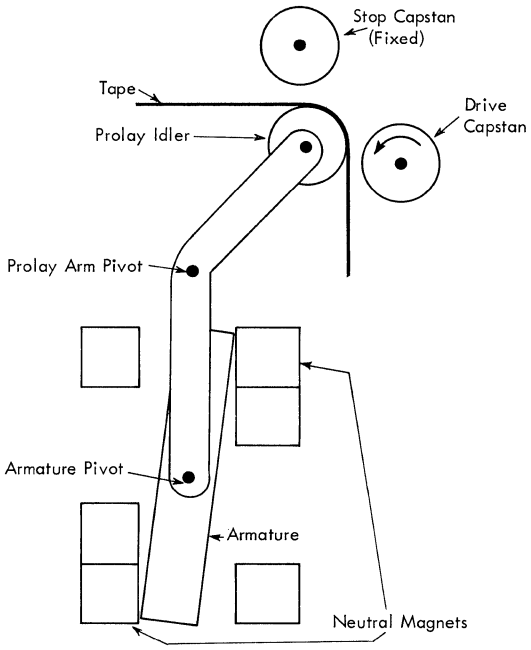


FIGURE 4.2-2. RIGHT PROLAY WITH NEUTRAL MAGNETS ENERGIZED

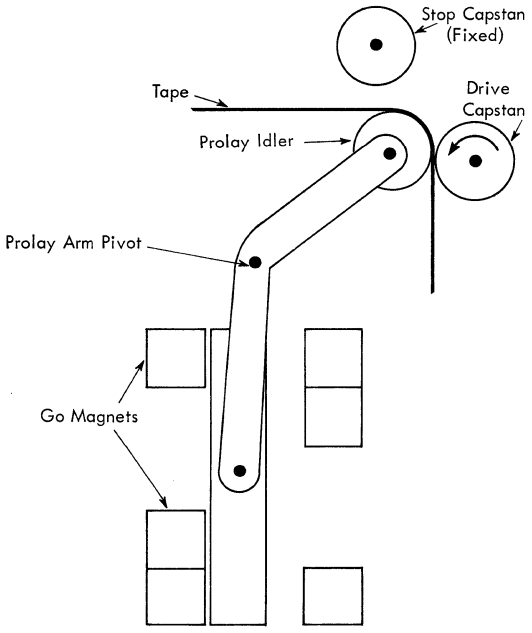


FIGURE 4.2-3. RIGHT PROLAY WITH GO MAGNETS ENERGIZED

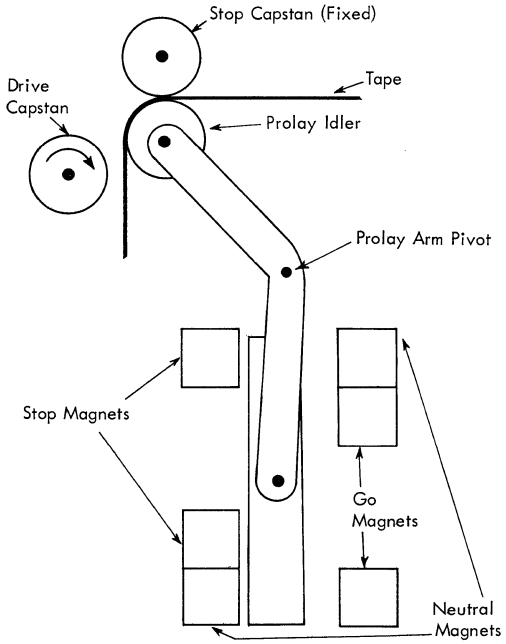


FIGURE 4.2-4. LEFT PROLAY SHOWING POSITION OF MAGNETS

When the neutral magnets are energized, the prolay armature assumes a slanted position as shown in Figure 4.2-2. This causes the arm to be in a vertical position, placing the prolay idler where it cannot contact either the drive capstan or the stop capstan. This is called neutral status.

Figure 4.2-3 shows the go magnets energized, causing the prolay armature to move to the left while maintaining a vertical position. This produces clockwise movement of the arm about its pivot point, causing the prolay idler to squeeze tape against the drive capstan.

The previous description covers operation of the right prolay. Operation of the left prolay is similar except that the prolay arm is bent in the opposite direction and the position of the stop and go magnets are reversed (Figure 4.2-4).

4.3.00 HEAD ASSEMBLY

The head assembly is constructed on two castings or plates. The lower plate is stationary, and the upper plate moves up and down under power, The two-gap read-write head, the tape break light, and the tape cleaner are on the lower plate. The load point and end-of-reel photo cell assemblies, split guides and head shield are on the upper plate. The shield prevents interaction between the read and write sections of the two-gap head.

The upper plate swings upward from the lower plate to allow threading of tape when the tape unit is in an unload status and to provide free movement of tape during high-speed rewind. When tape is transported through the machine for reading or writing, the upper plate is down, and the tape is held in close contact with the read-write head. The upper plate assembly is swung open and closed by a worm drive which is belt driven from a motor at the rear of the clutch frame. When the upper plate of the head assembly is fully closed, positive locking is provided. Figure 4.3-1 shows the head assembly both opened and closed. Two microswitches are used to sense the status of the head assembly. Connections to the read-write head, photo cells, lights and so on are made through three multipin connectors.

4.3.01 Two-Gap Read-Write Head

The two-gap head used in the IBM 729 II, III and IV Tape Units, contains seven write heads in laminated form, one adjacent to the other. The assembly also contains seven read heads. The two groups of heads are positioned so the gap in the write heads is three tenths of an inch to the left of the gap in the read heads. Tape passes over the head assembly, oxide side down, to complete the flux path of the write and read heads. The construction of the two-gap head is shown in Figure 4.3-2. By using separate heads for writing and reading it is possible to read a record for checking purposes, while it is being written.

The two-gap head eliminates the need for the separate erase head necessary in tape units having a single gap read-write head. Erasing now is accomplished by writing the new record over the old one. To provide for interchangeability of tape between tape units using the two-gap head, it is necessary for the read head to read a narrower track than that written by the write head. As illustrated in Figure 4.3-3,

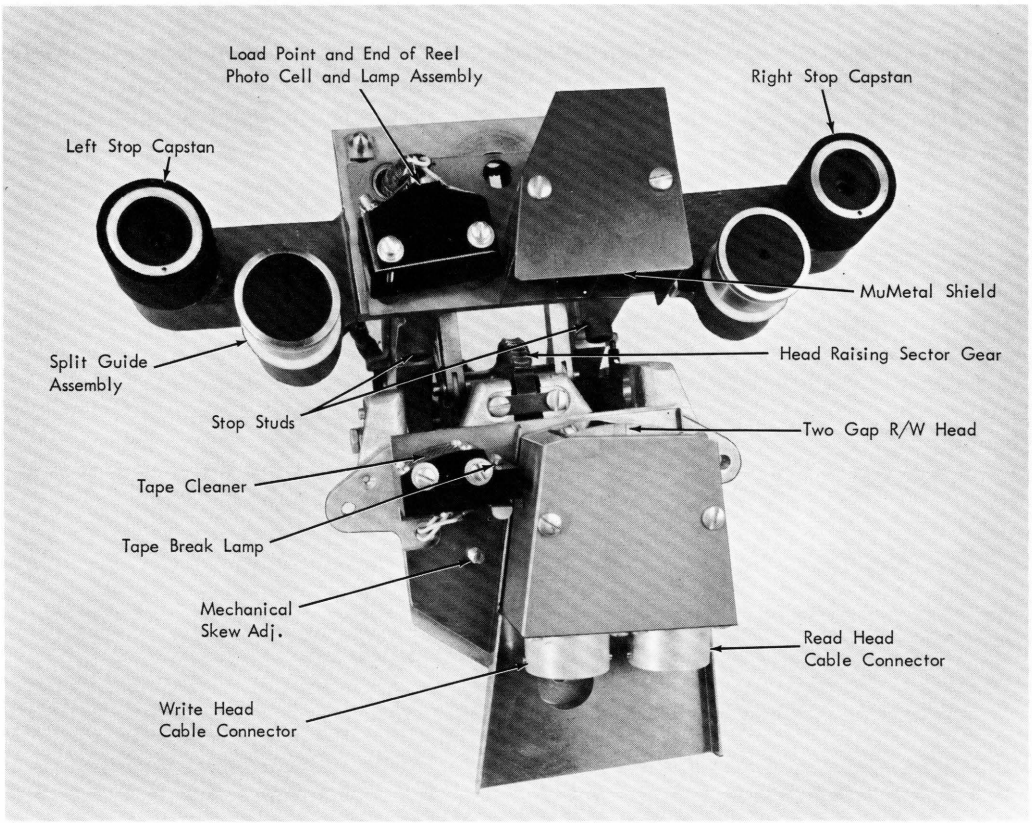


FIGURE 4.3-1 A. HEAD ASSEMBLY FRONT (OPEN)

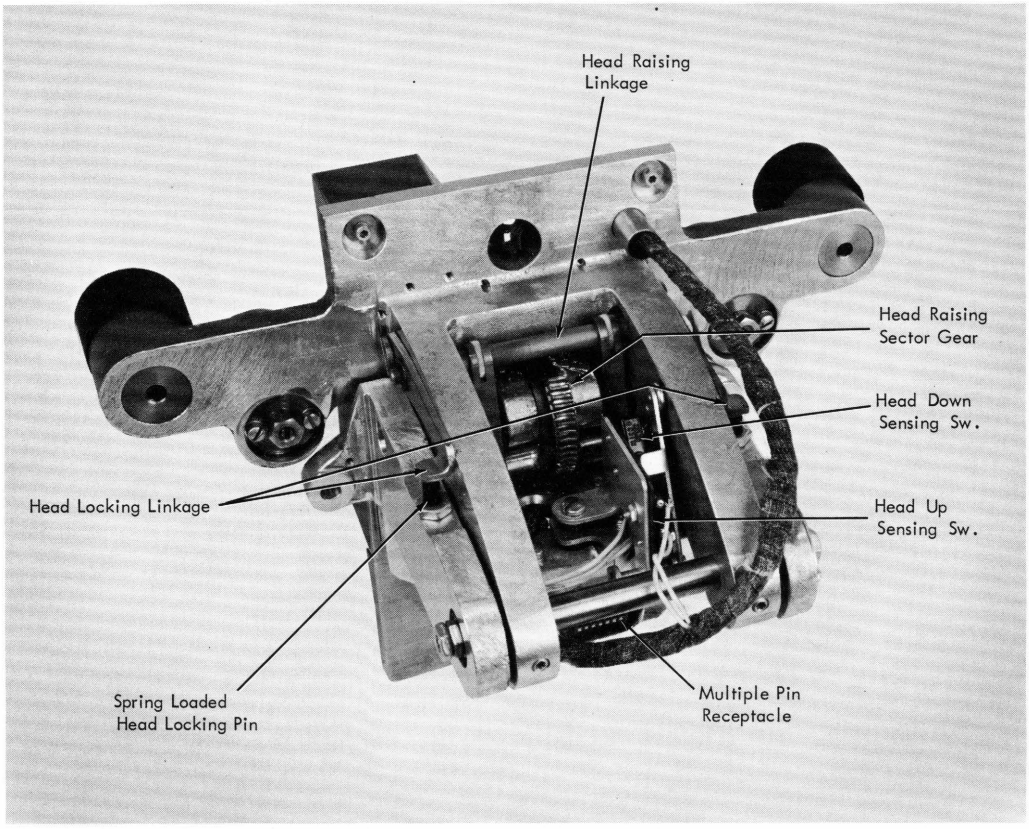


FIGURE 4.3-1 B. HEAD ASSEMBLY REAR (CLOSED)

there is no chance of reading an old record, even if the new record is written so that a portion of the old record is not erased. The width of the write track is .048 inch; the read track is only .030 inch wide. A safety factor of .009 inch exists on each side of the read track.

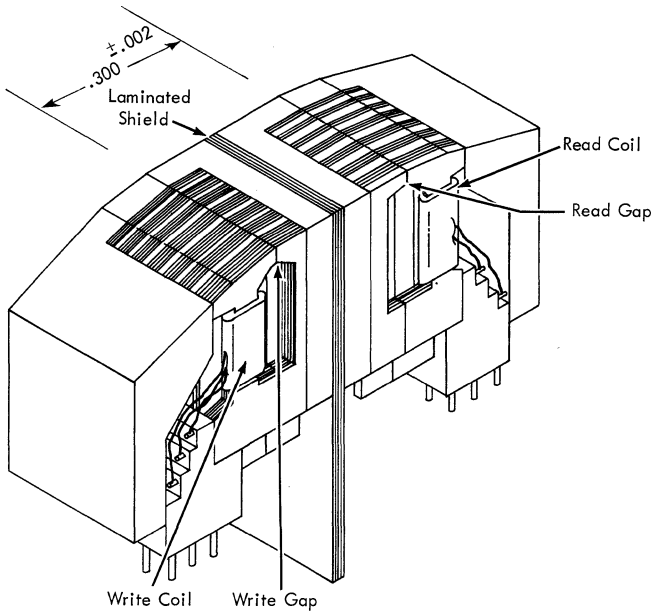


FIGURE 4.3-2. TWO-GAP READ-WRITE HEAD

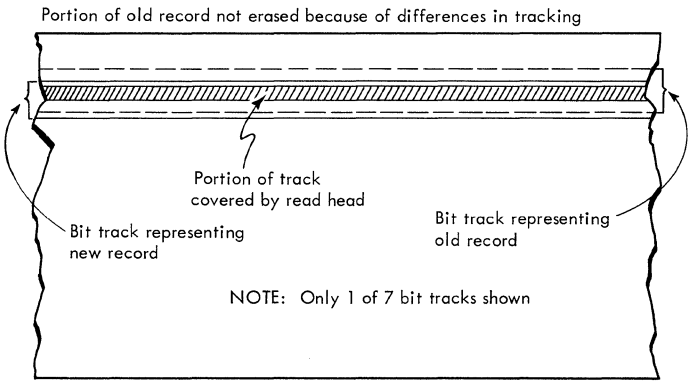


FIGURE 4.3-3. WRITE-WIDE READ-NARROW CONCEPT

4.3.02 Load Point Sensing

The load point is a small reflective spot (3/16 inch x 1 inch), placed on the plastic side of the tape, (1/32 inch from the front edge and 10 feet from the physical beginning of the tape). This reflective spot locates the beginning of the usable portion of the tape. The ten feet of tape preceding the spot is for threading the machine reel.

The load point is used only during a rewind operation. It is sensed by a photo cell arrangement (Figure 4.3-4). Light from the front bulb is reflected from the spot to the photo cell directly to the left of it.

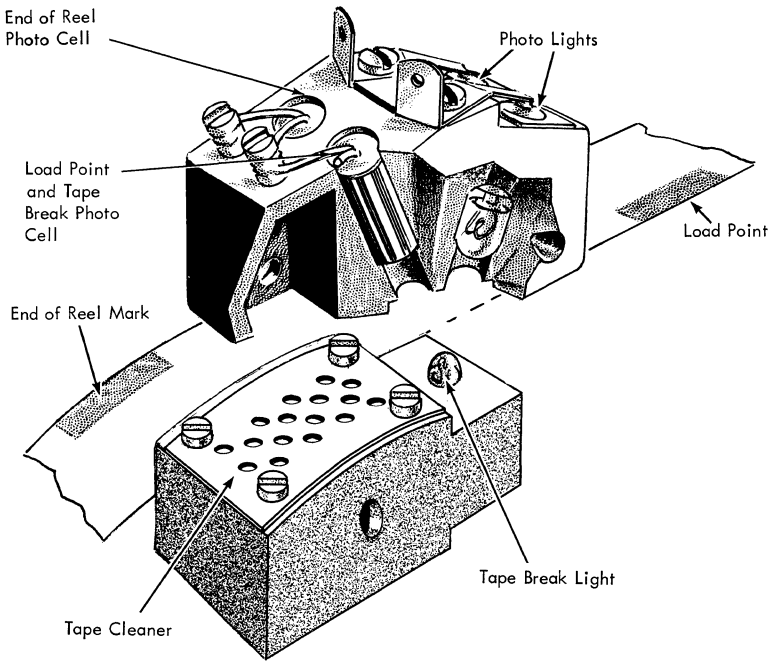


FIGURE 4.3-4. PHOTO-CELL SENSING

4.3.03 End-of-Reel Sensing

The end of the usuable portion of a reel of tape is indicated by a reflective spot about 18 feet from the end of the tape. This spot is placed on the plastic side of the tape 1/32" from the back edge. The photo cell (Figure 4.3-4) senses this reflective spot. If the tape unit is in write status when the end-of-reel reflective spot is sensed, a tape indicator trigger is turned on. If the tape unit is in read status when the reflective spot is sensed, there is no indication.

4.3.04 Tape Break

During a high-speed rewind operation, tape passes between a light source on the lower head plate (to the left of the read-write head) and the load-point photo cell. If the tape breaks, light strikes the load-point photo cell, causing the tape unit to stop.

4.3.05 Split Guide Assembly

Two split guides (Figure 4.3-5) maintain proper alignment of the tape as it passes over the read-write head. They are located on the upper head plate to the right and left of the head assembly. The split guides keep the tape parallel, at a fixed distance, to the front casting. Alignment between machines can be closely controlled. To avoid complex systems, alignment is maintained to one edge of the tape. The stationary

part of the guide holds the front edge of the tape at a fixed distance from the front casting. The rear portion of the guide is free to slide on the shaft and is held in continual contact with the rear edge of the tape by three spring loaded plungers which protrude from the upper head assembly casting.

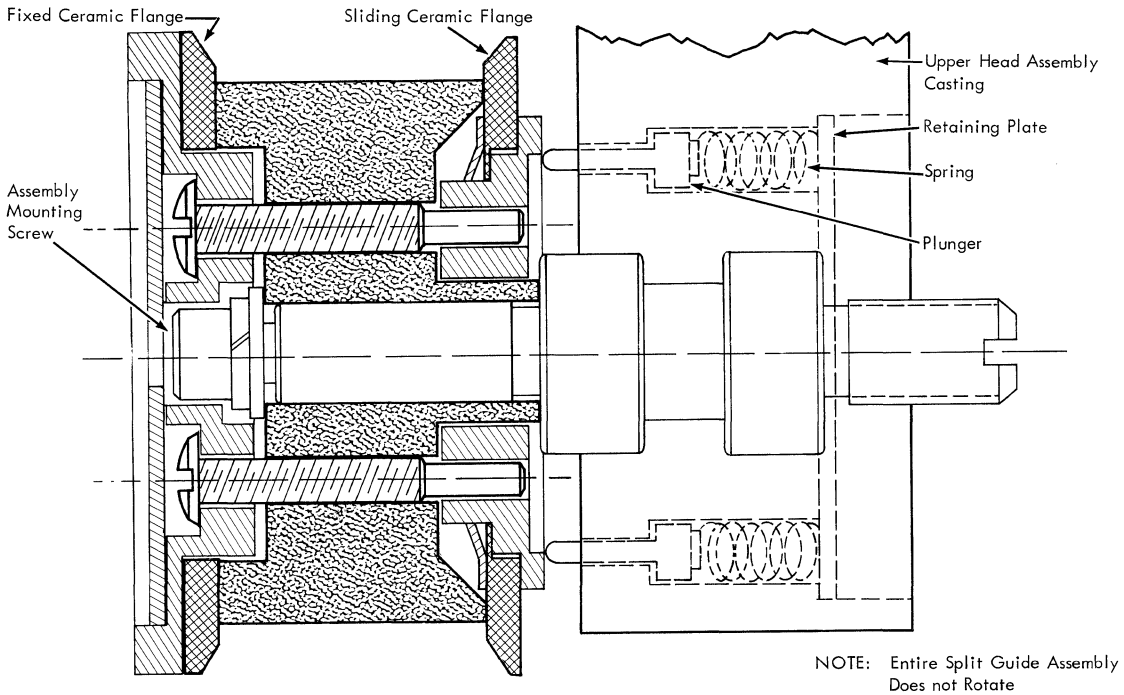


FIGURE 4.3-5. SPLIT GUIDE ASSEMBLY

When the tape expands in width, it spreads the split guide. The track farthest away from the front edge of the tape is most subject to misalignment when the tape expands or contracts laterally between the time of recording and the time of reading.

The inner flange surfaces of the split guides are lined with a ceramic material that is highly resistant to wear from tape passing over the guide at high speed. The entire split guide assembly is permanently mounted; it does not rotate when tape passes over it.

4.4.00 REEL DRIVE CLUTCHES

Each tape reel mounts on a hub protruding from the upper front of the tape unit. This hub contains a rubber rim that grips the reel tightly when the knob in the center of the hub is tightened.

The hub is on a shaft controlled by three magnetic powder type clutches: one for forward motion; one for reverse motion; and one for a brake. The innermost part of the magnetic clutch (Figure 4.4-1) is a rotor keyed to the reel shaft. Surrounding the rotor is the clutch housing which is mounted on sealed bearings and free to turn on the shaft. Each clutch housing (a three-groove pulley) is driven by a continuously running three-phase motor. Embedded in the clutch housing is a coil with its connections brought out to slip rings on one end of the housing.

Between the rotor and the housing is a mixture of iron powder and graphite. When current flows through the coil, flux is produced. The flux solidifies the iron and graphite mixture and causes the rotor and housing to be essentially locked together. Although the housing turns continuously through pulley action, the rotor does not move with it unless current is flowing through the coil. As current flows through the coil, the rotor begins to move with the housing, turning the hub and reel at the front of the machine.

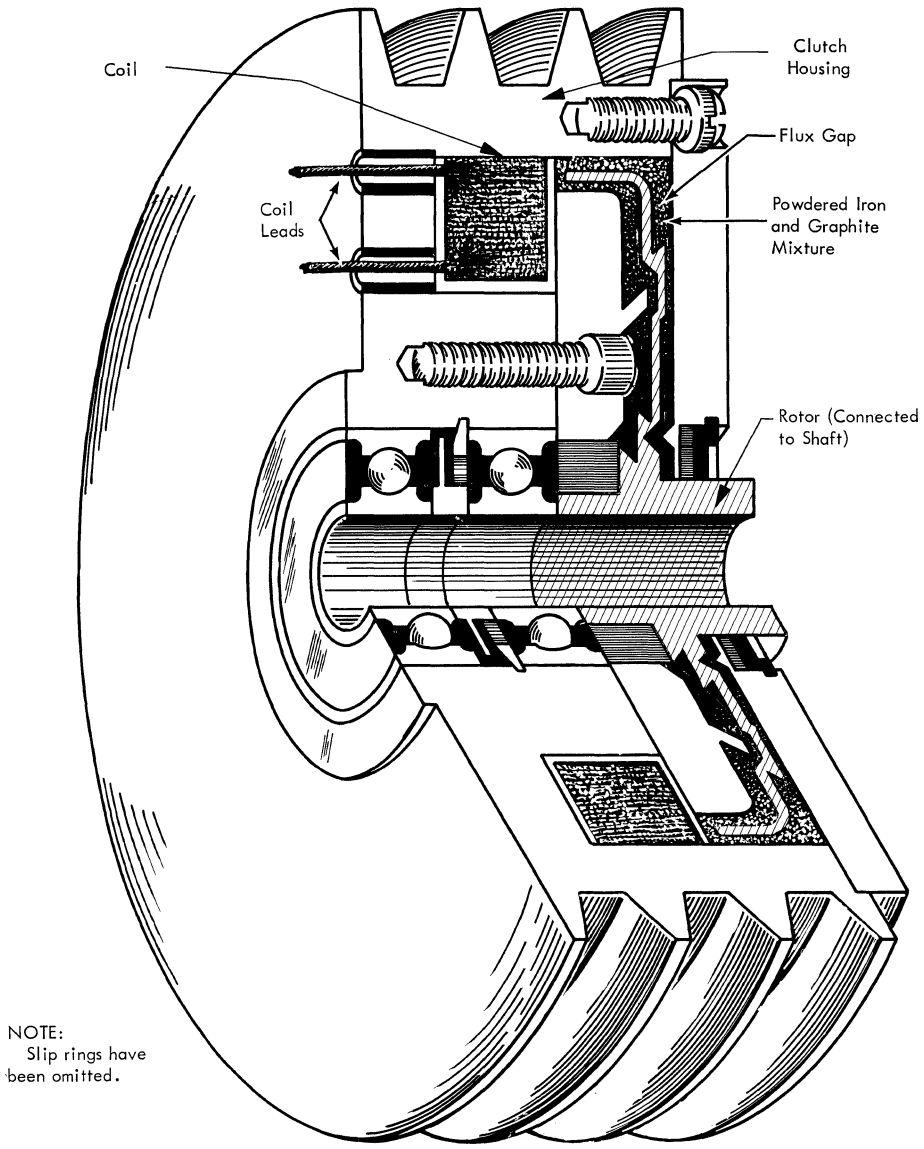


FIGURE 4.4-1. MAGNETIC CLUTCH

Because of the gradual build-up of current in the coil (due to inductance), the torque transmitted is proportional to the current, producing a smooth acceleration. This smooth acceleration prevents tape breakage by not shocking the tape into motion. The magnetic powder clutch was selected for its ability to produce smooth acceleration and large torque with small control current. To hold the iron-graphite mixture in the flux gap, a series of ridges are designed into the clutch parts. These ridges assist centrifugal force to keep the powder in the magnetic gap. The iron-graphite mixture polishes but does not wear the clutch parts.

Three clutches are mounted on each shaft with all rotors keyed to the shaft. The front clutch has a stationary housing and is a brake. The middle clutch housing is driven clockwise and is the forward drive. The rear clutch housing is driven counter-clockwise and is the reverse drive. Control of the clutch energization is discussed in Section 4.5.02.

In the unload status, both brake clutches are energized and are controlled by a reel release switch located below and to the left of the file reel (Figure 4.0-1). When this switch is depressed, power is removed from both brake clutches to permit them to be turned manually.

4.5.00 VACUUM COLUMNS AND VACUUM-OPERATED SWITCHES

The vacuum columns act as a storage area for the tape, allowing the tape to be moved across the head, at random, without having to turn the reels simultaneously. They also exert tension on the tape, preventing tape buckle at the head during starting and stopping.

4.5.01 Vacuum Columns

The vacuum columns are rectangular with inside dimensions of 2.5 inches x .510 inch (+.002, -.000). The transparent front of the column is hinged so it can be opened to permit easy cleaning. The top of the column is open; the lower end is connected to a manifold leading to a vacuum system that maintains a vacuum of about 16 inches of water with tape in the column. Tape hangs in the column so only the sides of the semi-circular loop touch the sides of the column. Vacuum is maintained below the tape loop in the column while atmospheric pressure exists above the loop. The vacuum columns are shown in Figure 4.0-1.

4.5.02 Vacuum Column Switches (Diaphragm Switches)

Each column contains two holes: one about 1/3 of the column length from the top; the other about 1/3 of the column length from the bottom. A vacuum-operated switch is attached, by a short tube, to each hole. As the tape loop is moved past the holes, the change in air pressure is sensed by the switch.

The vacuum column switch is shown in Figure 4.5-1. The presence of a vacuum causes the diaphragm to move in a direction to transfer the contacts of the switch. For greater reliability, two sets of contacts are used in parallel.

Forward Direction -- Reel Control. The tape reel drive clutches are controlled by vacuum column switch circuitry (Systems 02.03.1). As tape is pulled past the read-write head by the right drive capstan, it is pulled out of the left column. When the loop of tape is pulled above the upper Left vacuum switch in the column, the contacts transfer. This energizes the file reel forward clutch (left down) and the reel turns clockwise feeding more tape into the column. As soon as the tape loop moves below the upper switch, the left down clutch is de-energized and the brake is energized (left stop clutch). This causes the tape loop to oscillate about the upper vacuum column switch of the left column as long as tape is moving past the read-write head, in the forward direction. At the same time, tape is being fed into the right column by the right drive capstan. When the loop of tape in this column falls below the lower switch, the machine-reel forward clutch (right up) is energized and the reel turns clockwise to pull tape out of the column by winding it on the reel. As soon as the tape is again

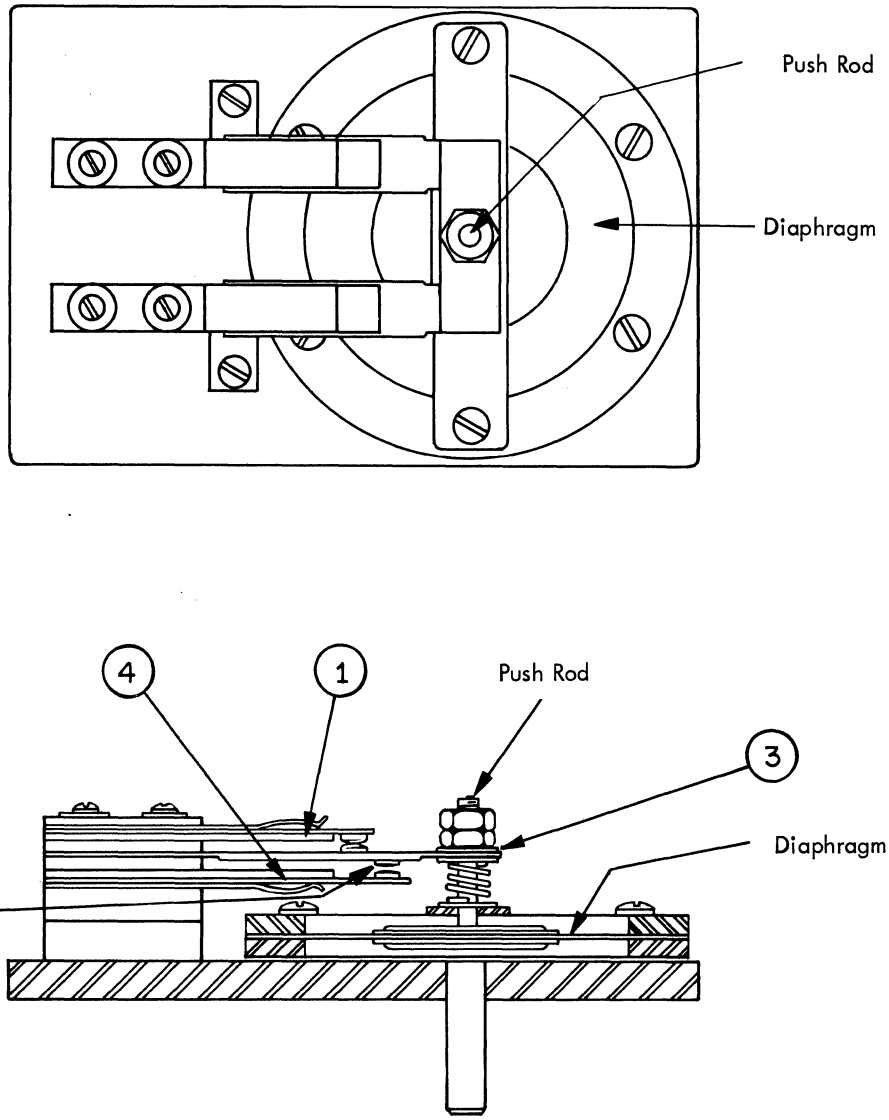


FIGURE 4.5-1. VACUUM COLUMN SWITCHES

above the lower switch, the right up clutch is de-energized, and the clutch brake is energized. This causes the tape loop to oscillate about the lower switch in the right column as the tape moves across the read-write head in the forward direction.

Reverse Direction. The action of the reels, and the tape in the columns, is the reverse of the forward action.

Whenever the tape is between the two vacuum column switches, the associated reel is stopped. When the loop is above the upper switch, more tape is fed into the column; when the loop is below the lower switch, tape is pulled from the column.

4.5.03 Vacuum-Off Bellows Switch

A bellows-type vacuum switch prevents machine operation until the vacuum is maintained above a certain level. The bellows switch is mounted on the manifold between the vacuum columns (Figure 4.5-2). When vacuum builds up within the manifold, atmospheric pressure causes the bellows portion of the switch to contract; the switch closes indicating that vacuum has reached the required level.

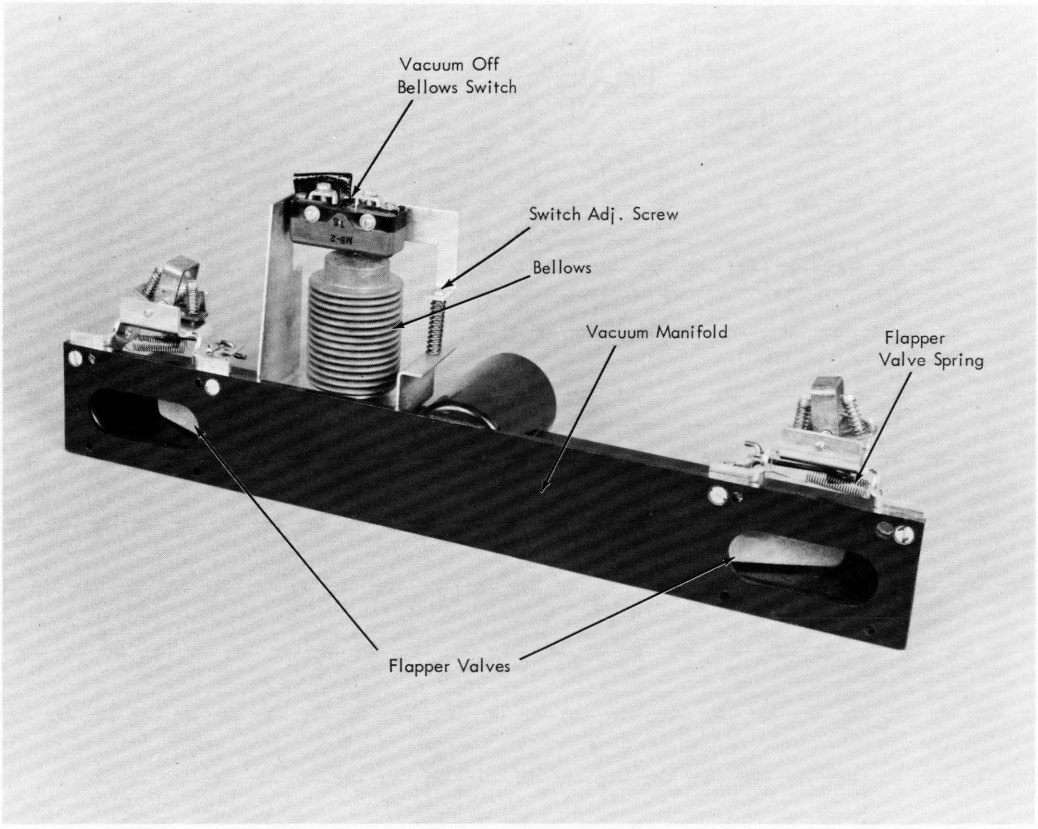


FIGURE 4.5-2. VACUUM MANIFOLD ASSEMBLY

4.5.04 Flapper Valves

At the bottom of each vacuum column, separating the column from the manifold, is a flapper valve. This valve is similar to a door held open under spring tension. A rush of air down the column strikes the flapper valve and closes it. When tape is in the column, very little air passes down the column, and spring tension pulls the flapper valve open. With tape out of the columns, the flapper valves close and help maintain enough vacuum in the manifold to keep the bellows switch closed.

4.5.05 Tape-in-Column Switches

A number of logical functions of the tape unit require that the presence of tape in the columns be sensed. This is accomplished by pressure sensitive switches called tape-in-column switches. One switch is mounted at the bottom rear of each vacuum column and is connected to the vacuum column by plastic tubing.

The tape-in-column switches are constructed like the vacuum column switches described in Section 4.5.02. The tape-in-column switches operate as follows. When tape is out of the columns the normally closed switch contacts are closed completing circuits to pick relays R5 and R6, the tape-out-of col relays. When tape enters the columns the flow of air in the columns is restricted and a partial vacuum is created. This causes the tape-in-column switches to operate; the normally closed switch contacts open, de-energizing R5 and R6.

4.6.00 MOTOR DRIVE

4.6.01 Forward and Reverse Drive Motors

The reel drive clutches are pulley driven by two 1/4 HP, three-phase, 220v, AC motors (1140 RPM). One motor provides forward motion; the other, reverse motion.

The forward drive motor is in the lower right corner and is connected to the two center clutches by two V-belts adjacent to each other. The reverse drive motor is in the lower left corner and is connected to the two rear clutches by two V-belts (Figure 4.6-1).

CAUTION

Use extreme care when working inside the tape unit to avoid injury from the reel drive motors and belts. Whenever possible, the motors should be unplugged as a safety precaution.

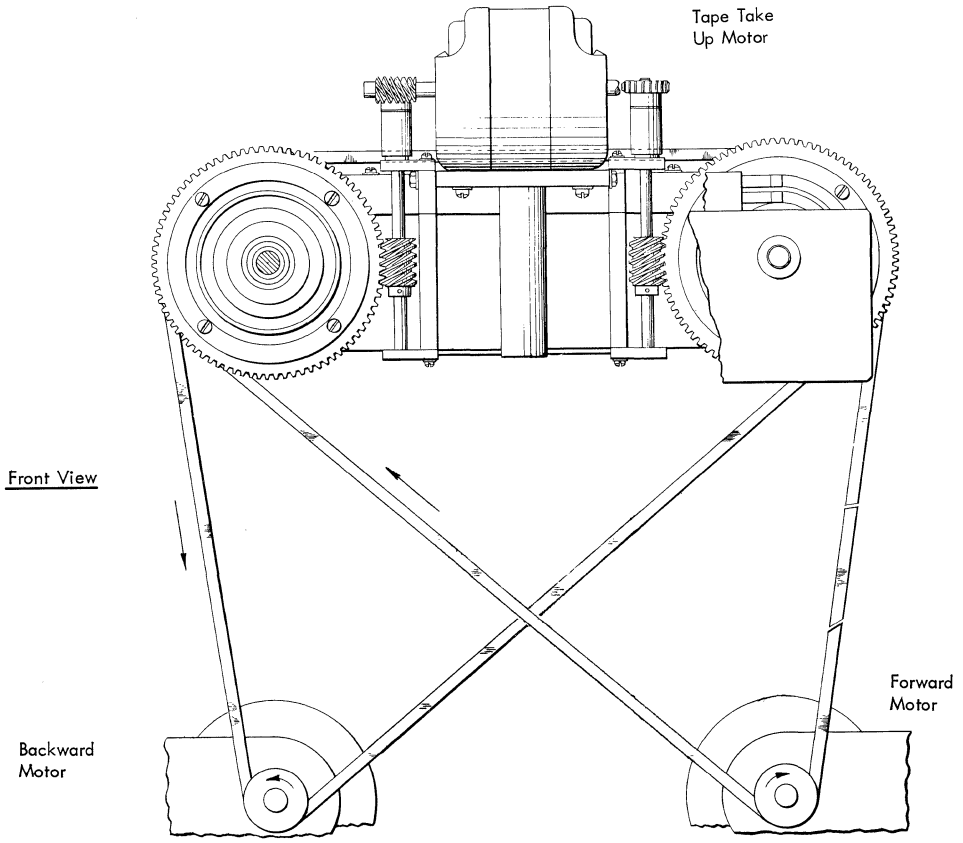


FIGURE 4.6-1. DRIVE MOTORS AND PULLEYS

4.6.02 High-Speed Rewind

To provide fast reel motion during high-speed rewind, an additional motor (1/2 HP, three-phase, 208v, AC, 3450 RPM) is direct coupled to the file reel shaft. During normal tape motion, the rotor is turned with the file reel shaft. When the tape unit goes into a high-speed rewind operation, the magnetic clutches are de-energized and the high-speed rewind motor drives the file reel shaft. Tape is pulled directly from the machine reel. The location of the high-speed rewind motor is shown in Figure 4.0-3.

4.6.03 Drive Capstans

Each drive capstan is mounted on the shaft of a reluctance synchronous motor (1/20 HP, 60 cycle, three-phase, 208v). See Figure 4.6-2. Each motor has a retractable rotor that provides a type of solenoid action to extend the capstan when the field is energized. When the field is de-energized, the capstan is retracted by a light spring (on the shaft) that exerts pressure on the turning rotor. This spring does not overcome the friction of the shaft when the capstan is not turning.

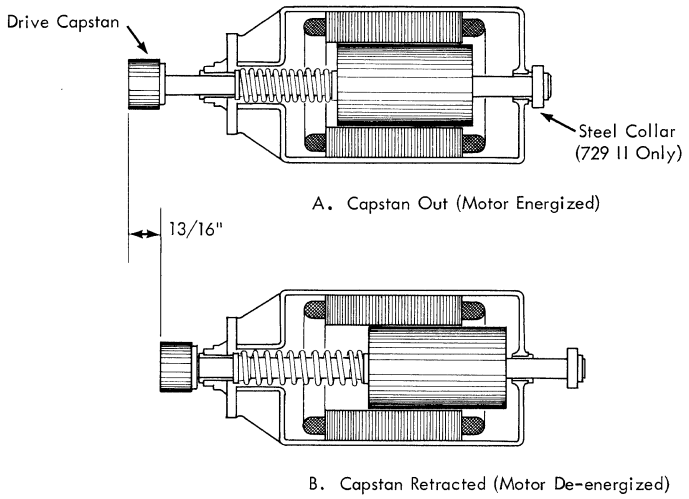
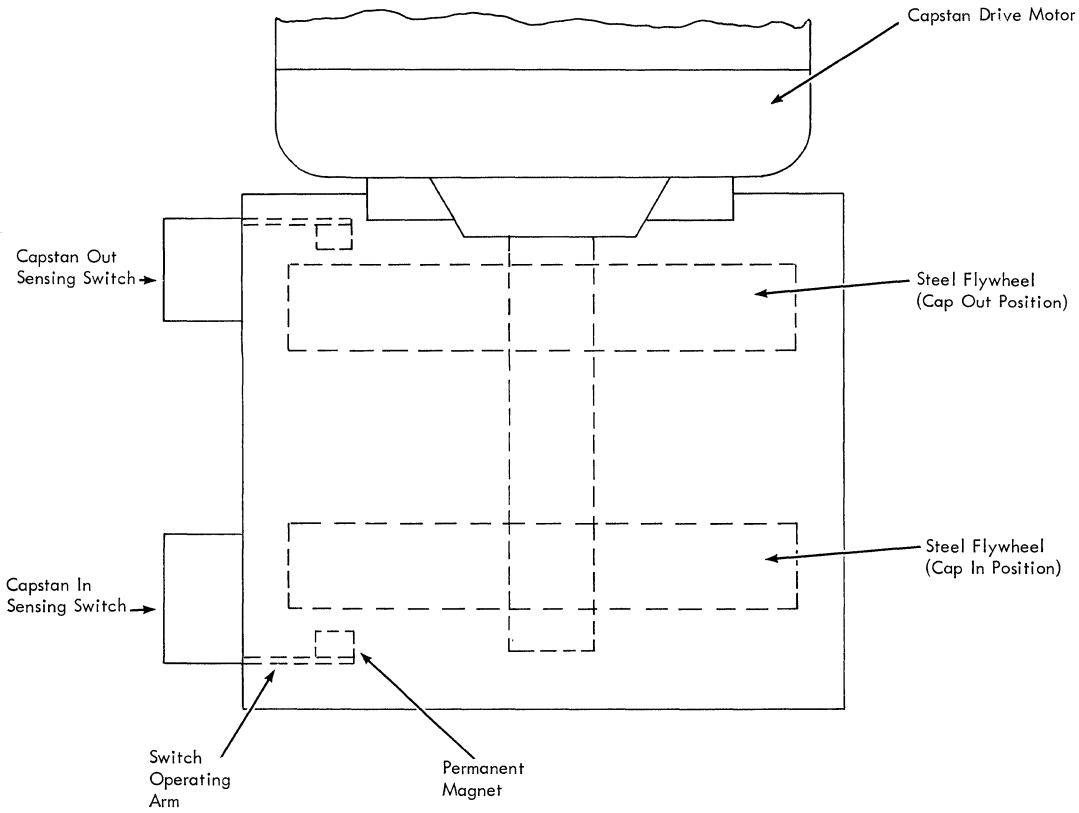


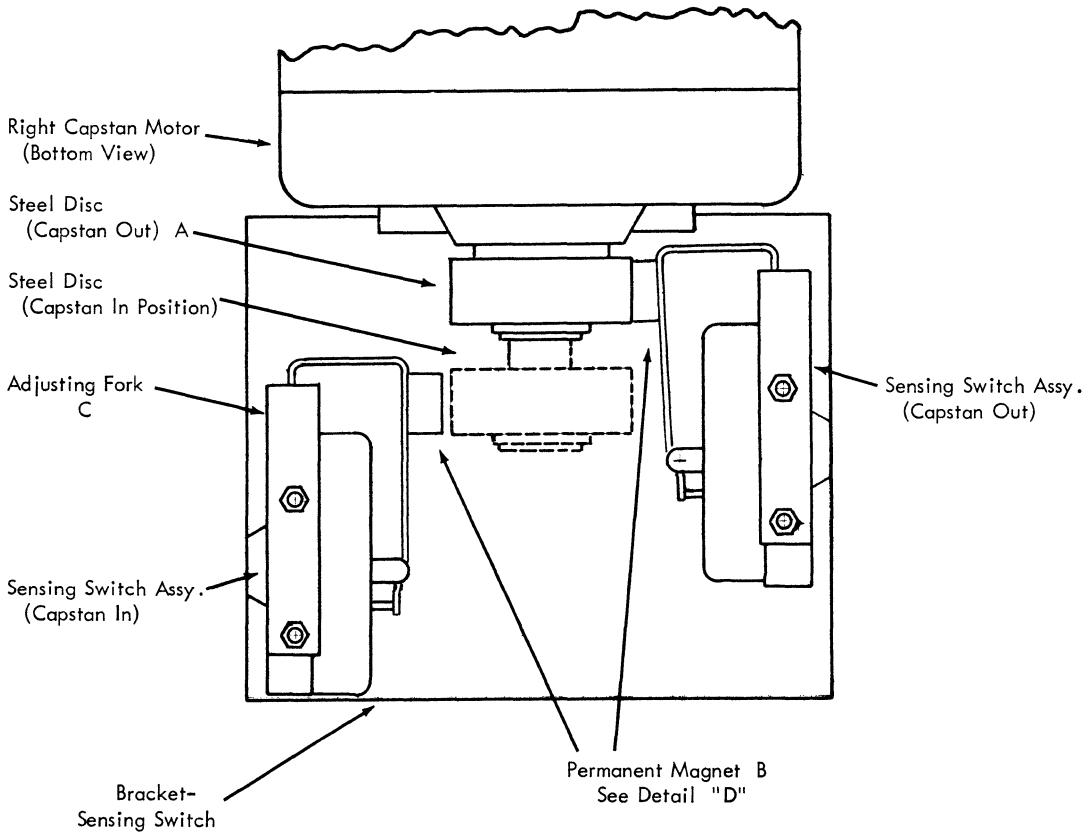
FIGURE 4.6-2. CAPSTAN DRIVE MOTOR

The position of the capstans is determined by two microswitches located on the rear of each capstan motor. Attached to the operating arm of each microswitch is a magnet that is attracted to a steel disk mounted on the rotor shaft. The capstan sensing switch arrangement is shown in Figure 4.6-3. Note, in Figure 4.6-3A, the large steel disk on the rear shaft of the capstan motor. This disk operates the sensing switches and acts as a flywheel for smooth operation of the high-speed tape units 729 III and IV.

Figure 4.6-3B shows the sensing mechanism of the 729 II tape unit. Because the 729 II operates at lower speeds, only a small steel collar is used to operate the sensing switches.



(A) 729 III and IV Tape Units



(B) 729 II Tape Unit

FIGURE 4.6-3. CAPSTAN SENSING SWITCHES

4.7.00 TIME DELAY UNIT

The time delay unit (a motor and a microswitch) is located on the relay gate. See Figure 4.7-1. At the end of a high-speed rewind, this mechanism delays machine operation to allow time for the reels to stop before tape is loaded into the columns. When the motor runs, it drives an operating arm through a reduction gear train. After a given time, the arm operates the microswitch (the time delay points). As long as the motor is energized, the operating arm holds the time delay switch transferred. When power is removed, the arm returns under spring tension. The length of the time delay is set with a calibrated dial on the front of the assembly. It is a 15-second timer, and the dial contains ten 1.5-second divisions. The factory setting of the timer is 4.2 (6.3 seconds).

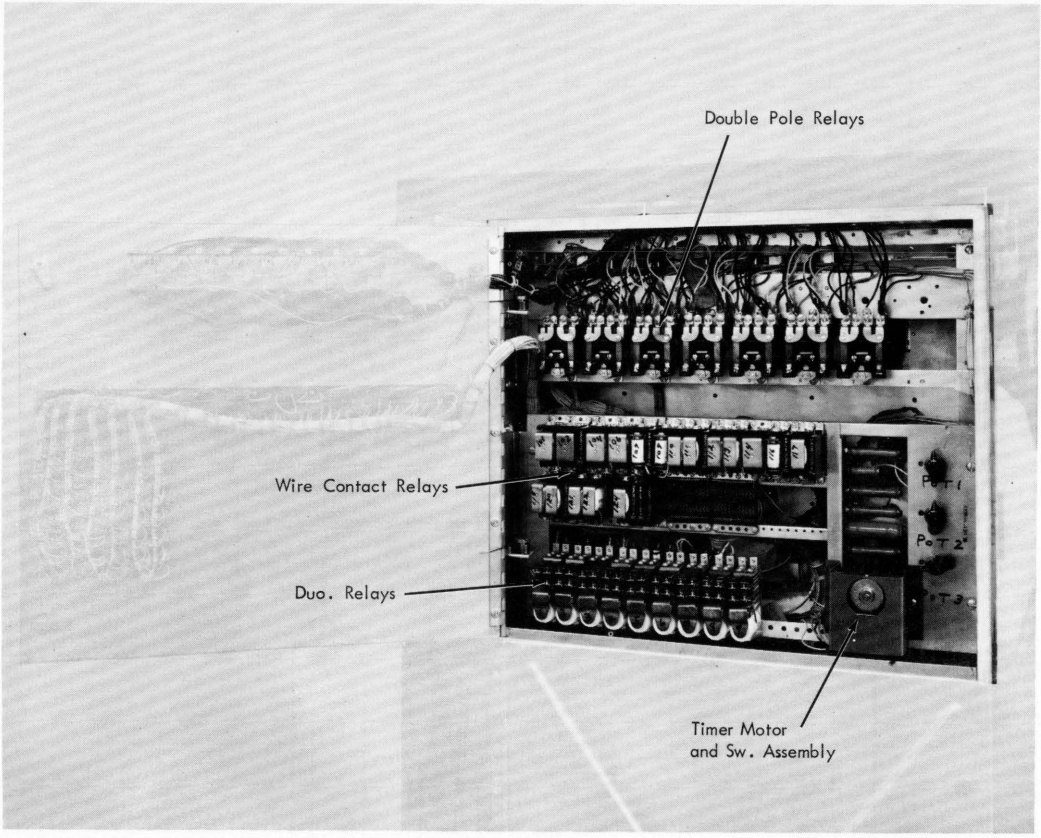


FIGURE 4.7-1. RELAY GATE

4.8.00 HEAD RAISING MECHANISM

The mechanism that raises the upper plate of the head assembly is a worm gear driven from a friction clutch and toothed belt by a three-phase motor which is mounted on the rear of the magnetic clutch frame. See Figure 4.8-1.

When the head take-up motor is operated, the worm shaft turns causing the upper plate to swing upward. When two phases are reversed and the motor is operated, the shaft turns in the opposite direction and lowers the upper plate of the head assembly.

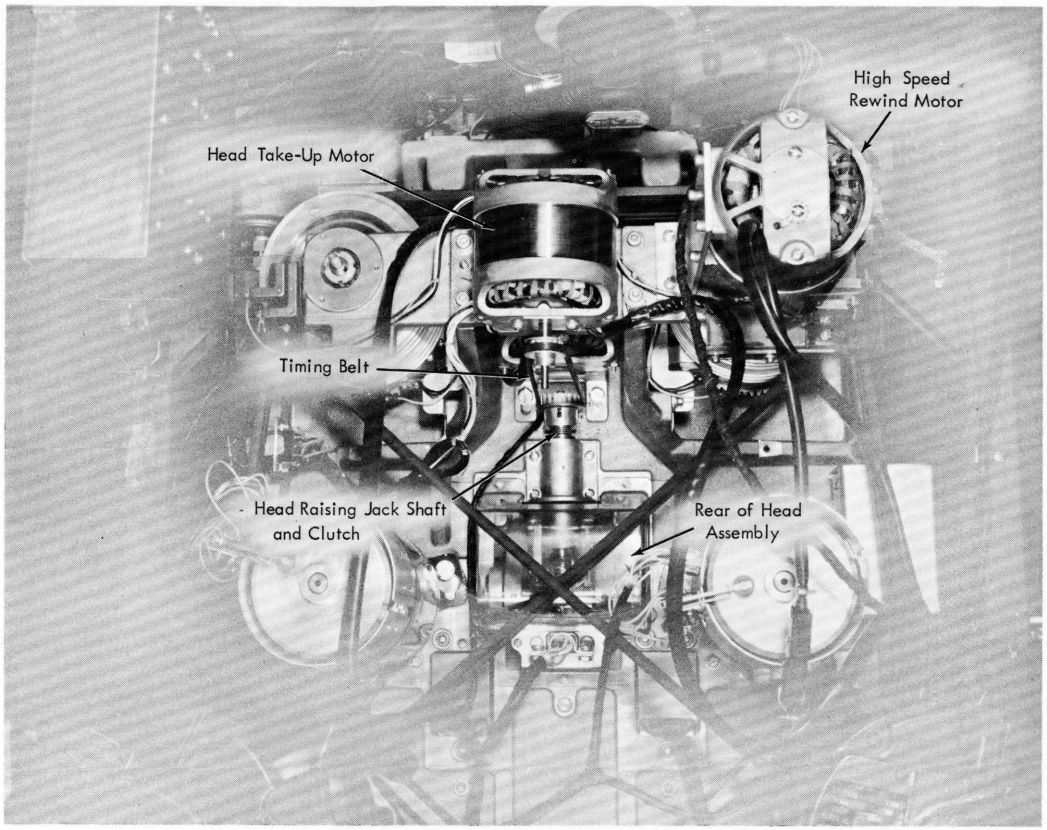


FIGURE 4.8-1. HEAD RAISING MECHANISM

4.9.00 TAPE TAKE-UP MECHANISM

The tape take-up mechanism is a three-phase motor mounted above and between the two reel clutch shafts (Figure 4.6-1). The tape take-up motor is geared to each brake clutch housing so that when the left stop clutch housing is rotated counterclockwise by the motor, the right stop clutch housing rotates clockwise. With the brake clutches energized, the tape reels rotate so tape will be removed from the columns. When the tape take-up motor is reversed and the brake clutches are energized, the tape reels rotate so tape is dropped into the vacuum columns. When the tape take-up motor is not operating, the brake clutch housings are held stationary by the worm drive mechanism.

4.10.00 REEL DOOR INTERLOCK

An interlock switch in the upper left corner of the tape unit is closed when the tape unit door and its sliding plastic panel are closed. When the door interlock switch contacts are open, operation of all drive motors is prevented. The interlock switch may be disabled for service and test purposes by a sliding plunger in the switch assembly.

4.11.00 FILE PROTECTION

To protect master files, a groove is molded in the rear side of each tape reel to prevent accidental writing on a reel of tape. A plastic ring may be placed in this groove. If the ring is not in the groove of the file reel, writing is suppressed but reading is allowed. If the ring is in the groove of the file reel, both reading and writing may occur.

To sense the presence of the ring, a pin protrudes from the front of the tape unit above the file reel hub (Figure 4.0-1). The pin is connected to the armature of a duo relay mounted behind the panel. If a ring is in the groove of the file reel, the pin is pushed to the rear, moving the relay armature. This action closes the relay contacts, energizing the relay to permit writing. When the relay is energized, the sensing pin is pulled clear of the plastic ring so it does not drag as the reel turns. If the groove in the reel is empty, the pin is not actuated, the relay is not energized, and writing is prevented.

4.12.00 POWER CONSIDERATIONS

All DC voltages necessary for operation of the tape unit and its transistor circuits are developed within the unit. These voltages are:

Voltage	Amp	Use
+6	1.5	Transistor logic circuits
-6	1.5	Transistor logic circuits
+12	1.0	Transistor logic circuits
-12	1.0	Transistor logic circuits
-7.5	20.0	Prolay driver circuits
+73	.165	Transistor neon indicator circuits
-48	2.0	Relay circuits
+140	5.1	Magnetic clutch circuit

Three-phase 208v, AC voltage is supplied to the tape unit through a power cable. Three-phase input is necessary for operation of the tape unit motors. A single phase of the three-phase input supplies power for the DC supplies. The three-phase input enters the tape unit through a three-pole contactor. This contactor is energized through a 208v line from the control unit and a power-on switch at the lower rear of the tape unit, below the tape connector receptacles.

CAUTION:
All safety precautions pertaining to high voltage work must be observed when working on the 729 tape units. In addition to the 208v three-phase input, dangerous voltage levels are present in the power supplies because of the resonant type voltage regulated transformers used.

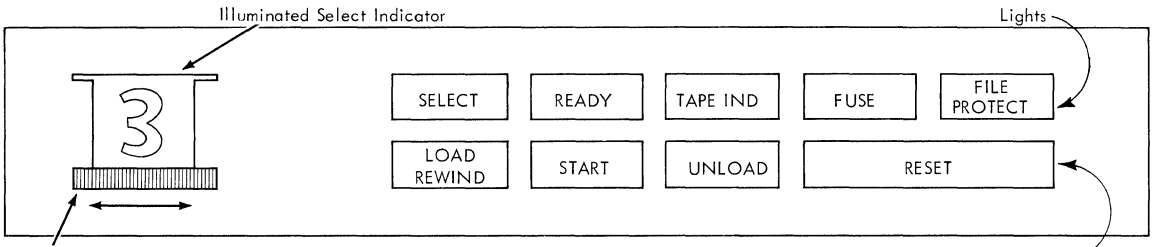
4.13.00 HIGH-SPEED REWIND PHOTO SENSING

A photo cell and light are used to determine the type of rewind that the tape unit will do. See Figure 4.0-1. The photo cell is located in the lower section of the finger guard; the light is located on the right corner of the top plate with its beam directed

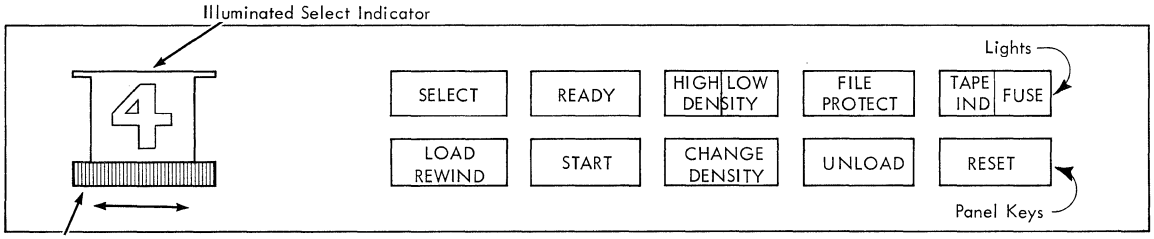
on the photo cell. When more than a half inch of tape is on the machine reel, the light path is blocked and tape rewind will be at high speed (average--500 inches per second). When less than one-half inch of tape is on the machine reel, rewind will be at low speed (normal tape speed: 729 II, 75 inches/sec; 729 III and IV, 112.5 inches/sec). During a high-speed rewind, when about one-half inch of tape remains on the machine reel, tape is allowed to coast to a stop. The tape is then lowered into the vacuum columns and rewinding is completed at low speed.

4.14.00 PANEL KEYS AND LIGHTS

The operating keys and lights (Figure 4.14-1) are located at the top of the tape unit.



A. IBM 729 III



B. IBM 729 II and IV

FIGURE 4.14-1. OPERATOR PANELS

Select switch

This is a rotary switch located at the left of the group. It is used to set the tape unit to any of ten addresses associated with an external source. The select switch is mounted horizontally and is operated by a large diameter knurled disk. Only a small section of the disk protrudes from the panel. The selected address is indicated on an illuminated translucent band which rotates with the knurled disk.

Select Light

The select light is on when the tape unit is selected by an external source.

Start Key	Depressing the start key places tape drive in a ready status if: (a) the tape unit is loaded and (b) the reel door interlock is closed. The start key may be depressed during a load or rewind operation, but the tape unit will not be in the ready status until conditions are satisfied.
Ready Light	This light is on if the tape unit is in a ready status. Manual control is indicated when the ready light is off if the tape unit is not rewinding or loading.
File Protection Light	This light is conditioned to turn off by mounting an unprotected reel on the unit (ring in file reel). It is on: (a) if no file reel is mounted, (b) if a file reel with no ring is mounted, (c) during a load and rewind operation.
Load-Rewind Key	Depressing this key starts two operations: (a) loading of the tape and (b) searching for the load point. If the tape has been unloaded manually in the high-speed rewind area of the tape (more than one half inch of tape on machine reel), depressing this key executes a high-speed rewind before the above operation takes place. This key is inoperative unless the tape unit is under manual control.
Unload Key	Depressing this key causes tape to be pulled out of the columns and the upper head assembly to rise, regardless of the distribution of tape on the two reels. If the tape is not at load point when the operator wishes to change it, a load-point search should be completed before the unload operation is started. The tape indicator is reset by depressing the unload key. This key is inoperative unless the tape drive is under manual control.
Tape Indicator Light	This light is lit when the tape indicator is turned on by: (a) reading a tape mark or (b) sensing the end of reel reflective spot on tape while writing. It may be turned off under external control or by depressing the unload key.

Reset Key	This key resets the tape drive (except the tape indicator) to manual control and can stop any tape operation that has been started, with the exception of an unload operation.
Fuse Indicator Light	This light is on when any AC or DC circuit protector is tripped.
Change Density Key	Depressing this key (Figure 4.14-1B) changes the status of the density trigger (employed on 729 II and IV tape units only).
Density Light	This light (Figure 4.14-1B) indicates status of the density trigger (high or low).

4.15.00 NEON PANEL

A neon panel is provided as a service aid for the customer engineer. This panel, on the upper rear gate of the tape unit, contains neon lamps which indicate the status of various relays, switches and triggers. Panel layout and a neon lamp location chart are on Systems 00.08.1.

5.0.00 TAPE HANDLING

MAGNETIC TAPE must be protected from dust and dirt; foreign particles can reduce the intensity of reading and recording pulses by increasing the gap between the tape and the head.

1. Keep tape in a dust-proof container whenever it is not in use on a tape unit. During loading, take the tape directly from the container; after unloading, place the tape directly in the container.

2. While the tape is on the machine, keep the container closed and put it where it is not exposed to dust or dirt.

3. Store tapes in an elevated cabinet away from paper or card dust to minimize the transfer of dust from the outside of the containers to the reel during loading or unloading.

4. Do not use the top of the tape unit as a working area. Placing material on top of the units exposes it to heat and dust from the blowers and may interfere with cooling the tape unit.

5. When identifying tape reels, use a material that can be removed without leaving a residue. Adhesive stickers, easily applied and removed, are satisfactory. They can be prepared in advance and applied during the loading procedure. Never alter identification by changing labels with an eraser. A card holder has been incorporated in the design of the new reel.

6. Place load points and reflective spots on tapes with care. Properly align and press them tightly on the tape with the back of the fingernail, preferably while the tape is loaded on a unit. If it is done away from the unit, keep unrolled tape off the floor and away from dust.

7. Inspect containers periodically; remove accumulated dust by washing with a household detergent.

8. When necessary to clean tape, wipe it gently with a clean, lint-free cloth moistened with IBM tape transport cleaner.

9. Exercise extreme care when removing the file protection ring. Under no circumstances should the ring be removed while the tape is loaded in the columns.

Recorded information comes within .020" of the edge of the tape. Proper operation relies on the edges being free from nicks and kinks.

1. Reels should be handled near the hub whenever possible. If a reel is difficult to remove, break the bond between the reel and the hub by placing the palm of the hands on the periphery of the reel and rotating it. Never rock the reel by grasping the outer edge.

2. Carefully avoid pinching reels or contacting the exposed edge of the tape.

3. When installing the reels, push them firmly against the stop on the mounting hub to insure good alignment.

4. Take special precautions to be sure the hub is tightened after the reel has been mounted.

5. When placing the tape on the take-up reel, carefully align the tape to prevent damaging the edge on the first few turns.

6. When winding the tape to load point, rotate the machine reel with the finger near the hub and on the reel. Rotating the reel with the finger in the cut out, nicks or curls the guiding edge of the tape.

7. Always place sponge rubber grommets or special clips on stored reels to prevent the free end from unwinding in the container.

8. If tape breaks, divide the reel into two smaller reels. Splicing is not recommended. If necessary to make a temporary splice to recover information, be sure to use special low cold flow splicing tape (Customer Engineering supply item).

9. Dropping a reel can easily damage both reel and tape. Use of a reel and tape after they have been dropped is usually unsatisfactory.

10. Never throw or mishandle reels, even while they are protected in their containers.

11. Allow the tape unit to complete the unload sequence before opening the door.

Magnetic tape, especially acetate tape, is sensitive to changes in humidity and temperature. Take the following precautions:

1. If possible, store tape where it is to be used (in the computer room). Tape storage near the tape units reduces handling and variations in atmospheric conditions.

2. The atmosphere should be controlled between the following limits:

Relative humidity	40% to 60%
Temperature	65° to 80° F

3. If tape must be removed from the computer room atmosphere, hermetically seal it in a plastic bag. If tape is not hermetically sealed then, it must be returned before reuse and allowed to remain in the computer room atmosphere for a time equal to the time it was away from the room. Twenty-four hour conditioning is necessary if the tape was removed for more than 24 hours.

When customers ship magnetic tape, the following procedure is advisable:

1. Pack the tape and reel securely in a dust proof container.

2. Hermetically seal the container in a plastic bag. (Ordinary plastic bags that can be sealed with a hot iron should be available from local merchants.)

3. Obtain additional support by enclosing containers in individual stiff cardboard shipping boxes.

For long-term storage, take the following precautions:

1. Provide proper mechanical support for the reels by using the dust proof containers.

2. Enclose the reel and container in a hermetically-sealed moisture-proof plastic bag.

3. Store tape in an area of constant temperature (between 40° and 120° F is satisfactory). Either freezing or excessively hot temperatures could harm the tape.

If a tape reel is dropped, the reel may be broken or bent, the edge of the magnetic tape itself may be crimped, and the magnetic tape may be soiled.

The tape should immediately be inspected. Breaking or bending can usually be verified by visual inspection. Bending can also be verified by mounting the reel on the hub of the tape frame. If the reel is bent or broken, it should not be used; the magnetic tape, however, may still be serviceable and can be wound on another reel.

If the edge of the tape is crimped, steps to be taken depend on whether it contains essential information. If the tape contains no essential information, discard the footage with the crimped edge. If the tape contains important information, reconstruct it through tape-to-printer or other machine operation. If this fails, the records in question must be recreated from the original input or control data.

Any time a tape reel has been dropped, clean the tape and reel thoroughly.

If visual inspection fails to uncover any evidence of breaking or bending of the reel, or crimping or other damage to the magnetic tape, assume that the tape is in good operating condition. If possible, make a test to verify that the tape operates properly before using it on subsequent runs.

The following are points of general tape-handling information.

1. Customer engineers and other IBM personnel should take special precautions to follow the tape handling recommendations to show, by example, the care required to insure good performance.

2. Replace any tape arriving at the customer's installation in unusable condition and return the faulty tape to the factory. To aid the factory in its inspection, ship the tape according to the shipping instructions outlined in this section.

3. Use discretion about smoking in the vicinity of tape because smoking adds to the dirt problem. Also, a hot ash could cause serious trouble with a reel of tape.

Mylar magnetic tape should be handled in the same way as acetate tape. However, if Mylar tape is removed from the computer room atmosphere for short periods (not in excess of 3 months), it is not necessary to hermetically seal the tape nor to recondition it after return to the computer room atmosphere. For long-term storage, Mylar tape should be hermetically sealed to guard against dirt, dust, and excessive moisture.

WARNING: Never store reels of tape near magnetic fields.

6.0.00 MOTION CONTROL

6.1.00 PROLAY DRIVING CIRCUIT

Tape motion is controlled by two prolays which operate the prolay idlers. Each prolay has three operating positions: stop, go, and neutral. The status of a prolay is determined by which one of its three sets of magnet coils is energized. The status of the prolays for various tape unit operating conditions is:

Tape Unit Status		Prolay Status	
		Left	Right
Fwd	Stop	Stop	Neutral
Fwd	Go	Neutral	Go
Bkwd	Stop	Neutral	Stop
Bkwd	Go	Go	Neutral

Prolay drive logic is shown on Systems 01.08.1 and, simplified, in Figure 6.1-1. Logic blocks in Figure 6.1-1 are numbered for easy reference; only blocks absolutely necessary to develop the circuit logic are shown.

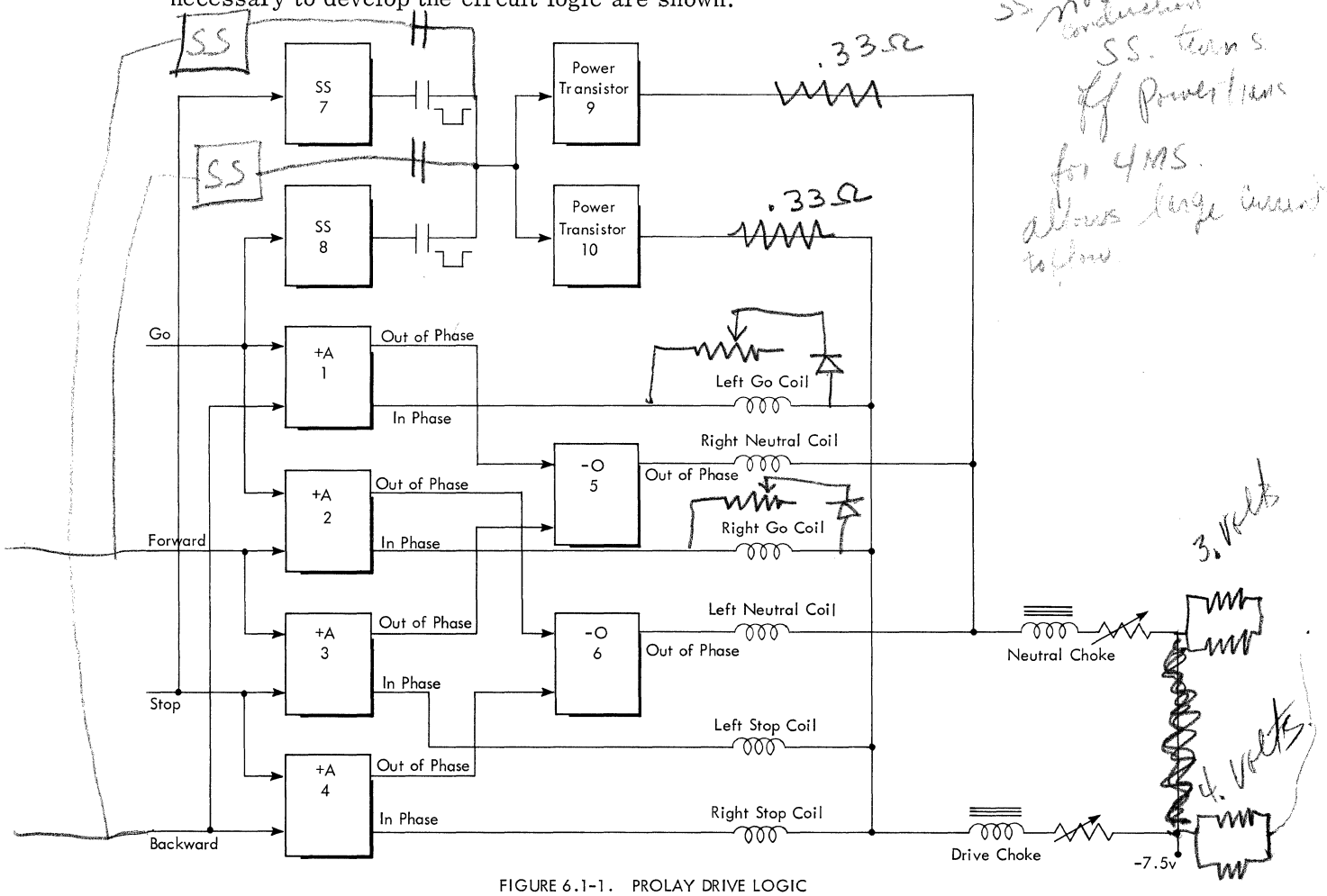


FIGURE 6.1-1. PROLAY DRIVE LOGIC

Consider prolay driver circuit operation when the tape unit is in forward stop status. The right prolay neutral coil and the left prolay stop coil will be energized (see Section 4.2.00). In Figure 6.1-1, the upper input leg of the +AND circuit (block 3) is the forward line which is at an up level (forward status). The lower input leg to the block is the stop line which is also up when the tape unit is in stop status. The in-phase output of the AND circuit (block 3) will be up, causing the left prolay stop coil to be energized. At this time the out-of-phase output line from the AND circuit (block 3) will be at a down level and feed the lower input leg of a -OR circuit (block 5). The out-of-phase output of this -OR circuit is at an up level, causing the right neutral coil to be energized. Similarly, prolay status for the remaining tape unit conditions shown in the table can be determined.

The single shots, represented by logic blocks 7 and 8, and the power transistors, blocks 9 and 10, are in the logic circuit to speed up the change of status of the prolays. This part of the circuit operates as follows.

Normally the power transistors (blocks 9 and 10) are in heavy conduction and the single shots are in their quiescient state. When there is a change of status from stop to go or go to stop, a negative shift is applied to the power transistors causing them to be cut-off for about five milliseconds. When the power transistors stop conducting, there is a voltage surge on the lines supplying the prolay coils, due to the chokes in the -7.5v supply lines. This surge permits a large current to flow momentarily to assist in changing prolay status.

After 4 milliseconds the power transistors again conduct and the prolay coils operate with reduced current until the tape unit is again stopped or started.

7.0.00 MANUAL OPERATIONS

THIS SECTION describes manual operations of the tape units. To aid in understanding the relay circuits, a simplified wiring diagram (Charts 1A and 1B) is provided. Connectors, filter circuits, and components not essential to study of the circuits have been omitted. The relay diagram is divided into horizontal sections 1, 2, 3, and 4; four vertical sections are lettered A, B, C, and D. Location of circuit components is given by a number and letter combination. Systems references are given for items not on Chart 1. Systems diagrams for the 729 tape units are included in Section 12.0.00.

7.1.00 LOAD REWIND

The load-rewind key starts two distinct operations: (1) loading tape and (2) rewinding the tape to load point. The rewinding operation is conditioned by depressing the key but does not begin until the last sequence of the load operation is completed.

Assume these initial conditions:

1. The power cable is connected to an external control that is a source of AC power. Power is off.
2. The tape unit is unloaded (the normal condition with power off); the capstans are in and the head cover is up.
3. No reels of tape are on the machine.

The sequence of bringing up power and load-rewinding follows (the file protection circuit is not covered):

Step 1. Turn on power in the unit controlling the tape drive. With power on, AC is supplied to the tape unit for the power supplies, blowers, and fan. The tape unit power-on switch at the rear of unit is closed.

Step 2. Mount the full reel of tape on the file reel and thread the tape past the idlers and read-write head assembly to the machine reel. The reel brakes may be released by pressing the switch below the file reel. Wind several turns of tape on the machine reel until the load point is well to the right of the head assembly. Close the reel door (the main door and sliding reel door must both be closed) and depress the load-rewind key.

Step 3. The vacuum motor and time-delay motor start turning, and the tape unit goes into a reverse status.

Step 4. At the end of the time delay (about six seconds), the vacuum is at operating strength. The tape take-up motor starts turning in a reverse direction, lowering tape into each column.

Step 5. As soon as tape enters either column, the head take-up motor operates in reverse, lowering the upper head assembly.

Step 6. The tape take-up motor is turned off when tape is in both columns. The head take-up motor is turned off when the head down switch transfers.

Step 7. The drive capstans start turning and are extended. When the capstan out switches indicate that both capstans are fully extended, the machine has completed the load operation. The machine then goes into a start status, and tape moves in a reverse direction until the load point is sensed. When the start key is depressing the machine will be in the ready status.

Following is the relay operation for load rewind. The wiring diagram (Charts 1A and B) and sequence diagram (Chart 2) are used with this description. Locations of relays on the wiring diagram are included in the sequence diagram.

7.1.01 Power On

When power is turned on, the 48v DC supply is energized from phases 1 and 2 of the three-phase, 208v, AC supply. The gate blower and pressure blower are energized from phases 1, 2, and 3 (Systems 02.04.1).

The following relays can pick with the 48v DC supply, because the tape unit is assumed to be unloaded (Chart 2).

7.1.02 Manual Load Rewind Sequence (Chart 2)

Location on Chart 1	Sequence of Operations	Conditions	Remarks
4B 2D	R107, unload 1, and R109, unload stop, are latched		These relays were latched the last time the machine was unloaded.
3D	Pick R102, unload 2, R122 unload 2	R107-3n/o	
4C	Pick R7		Circuit through the load point, tape indicator, and tape break lamps.
1B	Pick R2 and R120, clutch status 1 and 2	R107-2n/o	
1D	Pick 119, go status	R109-1n/o	
Systems 02.03.1	Full power to both stop clutches	R1BUn/c and R1BLn/c	Power to stop clutches is controlled by reel release sw.
4C	Tape break lamp on		Used for H-S rewind area.
4C	Reset tape indicator	R110-3n/o	Tape indicator trigger is held reset until R110 is picked when the load rewind key is depressed.
2B	Reset write status tgr	R106-3n/o	Called "read trigger set." Write status trigger is held reset until the start relay R106 is picked

Location on Chart 1	Sequence of Operations	Conditions	Remarks
3D	Manual go line up	R119-1n/c	Manual go will fall when R119 is de-energized.
3D	Pick R5 and R6 tape out-of-col relays	Thru the tape-in-col switches n/c points when 48v is applied	Tape-in-col switches will transfer when tape enters cols.
Thread tape on tape unit.			
4A	Depress load-rewind key		
4C	Pick R111, rewind pick up	R7BL, read status, relay driver (01.09.1)	R111 has no hold. It remains picked only as long as key is depressed.
4B	LT R107, unload 1	R111-3n/o	Drop unload status relays.
1D	LT R109, unload stop	R111-2n/o	
	Drop R119 manual go	R109-1n/o	
3D	Drop R102 and R122, unload 2 and 3	R107-3n/o	
1D	Pick DP4, vacuum mtrs		Two pumps are used to obtain sufficient vacuum.
4D	Pick R3, load rewind 1	R111-1n/o	Starts load rewind operation. Used for load operation only.
3B	Pick R4, high-speed rewind, end 1 and DP7, take-up mtr reverse	R3ALn/o	R4 controls low-speed rewind. DP7 prepares the head and tape take-up mtrs to run in reverse to lower head and drop tape in cols.
1B	R2 and R120 held	R3BLn/o	Picked from unload status.
1B	Pick R8, time delay mtr	R4AUn/o	
Systems 02.04.1	Time delay mtr starts	R8AUn/o	
4D	Pick R101, load rewind 2	R3BUn/o	Used with R3 for load operation only. R101-4 points hold R3.

Location on Chart 1	Sequence of Operations	Conditions	Remarks
3B	Pick R104 and R9 status 1 and 2	R101-5n/o	Used for rewind operation after the load operation.
1D	Manual reverse line to 01.07.1	R104-1n/o	Prolays conditioned for backward tape movement.

The above operations take place within a fraction of a second after the load-rewind key is depressed. When enough vacuum is obtained, the flapper valves and the bellows switch transfer, causing the following action.

1B	Pick R1, run DP1, and DP2 phases 1, and 2	Vacuum off bellows sw	
Systems (02.03.1)	One-half power applied to stop clutches	R1BUn/o, R2A-Ln/o R1BLn/o, R2B-Un/o	One-half brake is always applied with R1 and R2 picked.
3D	Time delay switch transfers		
3D	Pick DP6 tape take-up motor start	Time delay points transfer	
Systems 02.04.1	Start tape take-up mtr	DP6 points	Tape take-up mtr operates in reverse, and tape goes into cols.

When tape goes in the columns, the tape-in-col switches transfer, dropping their associated relays.

3D	Drop R5 and R6, tape out of cols	Tape-in-col switches transfer	
2D	Pick DP8 head take-up motor start	R5BUn/c or R6BUn/c	Head take-up motor operates in reverse. Upper head assembly moves down.
2C	Head up switch transfers	Head moves away from upper limit	
2C	Head down switch opens	Head near its lower limit	
2D	Drop DP8 head take-up motor start	Head down switch opens	Stop head take-up motor.

Location on Chart 1	Sequence of Operations	Conditions	Remarks
1B	Drop R8 time delay motor	Head down switch opens	Time delay motor has been held energized.
1B	Drop R2 and R120 clutch status 1 and 2	Head down switch points	
	Tape reels under control of vacuum cols	R2ALn/c and R2BUn/c	Tape is adjusted in cols.
3D	Drop DP6 tape take-up mtr start	Time delay switch opens	Stop tape take-up mtr.
4D	Tape break lamp is shunted	R120-3n/c	Not usable when tape drive is loaded.
3D	Pick DP3, capstans motors	R2AUn/c	
Systems 02.04.1	Capstans motors start and extend	DP3 points	Capstans extend because of solenoid action of rotors.
3C	Capstans in switches open	Capstans extending	
3C	Caps out switches close	Caps fully extended	
3D	Pick R117 caps out	Both cap out switches closed	
4D	Drop R3, load rewind	R117-2n/c	
4D	Drop R101, load rewind 2	R3BUn/o	
3B	Drop R4, H-S rewind end	R3ALn/o	
The load operation is completed. The rewind operation may now be started.			
1D	Pick R119, manual go	R101-3n/c	
3D	"Manual go" up	R119-1n/c	The reverse line has been up since R104 was picked.

Tape moves in the reverse direction until the load point photo cell senses the load point reflective spot. As tape passes under the load point photo cell, light is reflected by the load point reflective spot to the photo cell causing increased conduction in the cell. The photo cell output is a negative shift that is applied to a converter (Systems 01.06.1). The negative shift output from the converter is combined with "reverse" in minus AND circuit D12. The output of AND circuit D12 is used to turn on the pick load point trigger. The negative shift on the in-phase N level output line from the trigger is used to latch pick the load point PU relay R116.

The negative shift on the in-phase N level output line from the trigger also causes the output of + AND circuit E13 (Systems 01.07.1) to fall. This in turn causes the GO line to fall and the stop line to rise, putting the tape unit in a reverse stop status.

Location on Chart 1	Sequence of Operations	Conditions	Remarks
4C	Latch pick R116	Photo cell	Tape break and load point relay.
3B	Drop R9 and R104	R116-1n/c	End of rewind operation.
1D	Drop R119	R116-1n/c	
3D	Drop manual go	R119-1n/c	

When R104 drops, the manual reverse line is deconditioned. This causes the "backward" line to fall (Systems 01.07.1) and the "forward" line to rise. The tape unit will now be in forward stop status.

The +N level "forward" line is combined with "at load point" in +AND circuit D14 (Systems 01.06.1). The output of this AND circuit is used to reset the "pick load point" trigger.

7.2.00 UNLOAD OPERATION

To remove a reel of tape and mount a new reel, the tape unit must be in unload status. Unload status may be obtained by depressing the reset key and then the unload key. (Depressing the reset key is necessary only if the ready light is lit.) During the unload operation: the capstans are retracted, tape is pulled from the columns, and the upper head assembly is raised. At the end of the operation, all motors, except the fan and blower, are stopped. The following sequence takes place (Sequence Diagram, Chart 3).

7.2.01 Loaded Status

Because the tape drive is in load status, the vacuum-off bellows switch is closed and the following relays are picked: R1, 7, 110, 117, and DP1, 2, 3, 4, and 7. (The file protection circuit is not covered.)

7.2.02 Manual Unload Sequence (Chart 3)

Location on Chart 1	Sequence of Operations	Conditions	Remarks
4A	Depress the unload key		Door must be closed. If R106 is up, it must be dropped by depressing the reset key.
4B	Latch pick R107 unload 1	Unload switch	R107-1 points form a parallel circuit to hold R1, 1 and 2.
1B	Pick R2 and R120 clutch status 1 and 2	R107-2n/o	
3D	Drop DP3, caps mtrs	R2AUn/c	Caps retract as motors coast to stop.
3D	Pick R102 and R122, unload 2 and 3	R107-3n/c	
4D	Tape break lamp lights Tape indicator and load point lamps shunted	R120-3	The tape break lamp is lighted when going into, and in, an unload condition.
3C	Caps-out switches open	Caps moving in	
3D	Drop R117 Capstans-out relay	Caps-out switches open	
3B	Drop DP7 Take-up motors rev	117-1n/o	
3C	Caps-in switches close	Caps fully retracted	
3D	Pick DP6 tape take-up motors start	Caps-in switches	Tape is pulled from cols.
3C	Tape-in-col switches n/c points close	Tape out of cols	
3D	Pick R5 and R6 tape out of col relays	Tape-in-col switches n/c points closed	
3D	Drop DP6 tape take-up motor	5BUn/c 6BUn/c	Tape take-up motor stops.
2D	Pick DP8 head take-up motor start	R5BUn/o R6BUn/o	Upper head assembly rises.

Location on Chart 1	Sequence of Operations	Conditions	Remarks
Systems 02.03.1	Half-brake left and right	R5BLn/o R6BLn/o	
2C	Head down switch transfers	Upper head assembly rising	
2C	Head up switch transfers	Upper head assembly fully raised	
2D	Drop DP8 head take-up mtr	Head up switch	
2D	Latch pick R109 unload stop 1	Head up switch	
1D	Drop DP4 vacuum mtr	109-1n/c	Vacuum starts decreasing.
1D	Pick R119 manual go	109-1n/o	
1B	Vacuum off bellows sw opens	No vacuum	
1B	Drop R1 run	Vacuum off bellows sw open	
1B	Drop phase 1 and 2, DP1, DP2	Vacuum off bellows sw open	

The tape unit is now in unloaded status. All motors are stopped except the fan and blower motors. The tape unit remains in this status until the load-rewind key is depressed.

7.3.00 HIGH-SPEED REWIND

Time is of prime importance in handling large amounts of tape by the tape unit. When a tape has been written or read and the bulk of the tape is on the machine reel, it is best to rewind the tape at high speed. A high-speed rewind may be started when at least one-half inch of tape is on the machine reel.

7.3.01 Initial Conditions

Assume the tape to be in the load status (tape in both columns, upper head assembly down, drive capstans extended and turning, and more than one-half inch of tape on the machine reel). The following sequence takes place (Sequence Diagram, Chart 4).

Because the tape unit is in the load status, the vacuum-off bellows switch is closed, and the following relays are picked: R1, 7, and 117; DP1, 2, 3, 4, and 7. (The file protection circuit is not discussed in this section.)

In addition to the above relays, R121 is picked in the following manner. The high-speed area lamp beam is blocked by the tape on the machine reel. Because the beam cannot strike the photo cell, the cell's conduction is light, causing a negative voltage level to be applied to the base of the transistor amplifier (Systems 01.09.1). The amplifier conducts, producing a +P level at its output. The +P level is applied to a relay driver to pick R121, the high speed area relay, which allows the tape unit to perform a high-speed rewind. When enough tape has been removed from the machine reel, the light beam again strikes the photo cell causing it to conduct heavily. This raises the base of the transistor amplifier to a positive level which cuts it off and causes the output to drop to a -"P" level cutting off the relay driver (System 01.09.1) which causes R121 to drop. Dropping R121 permits a low-speed rewind operation to begin.

The high-speed rewind circuit is designed for safety. If the high-speed area lamp burns out or the photocell amplifier transistor opens, the tape unit cannot perform a high-speed rewind.

7.3.02 High-Speed Rewind Sequence (Chart 4)

Location on Chart 1	Sequence of Operations	Conditions	Remarks
4A	Depress load-rewind key	R106-4n/c Ready light must be out	Reset key must be depressed if ready light is lit.
4C	Pick R111, rewind pick up	R7BL, read status, relay driver (Systems 01.09.1)	R111 has no hold. It remains picked only as long as key is depressed.
4D	Pick R3, load-rewind 1	R111-1n/o	Starts load-rewind operation. Used for load operation only.
4D	Pick R101, load-rewind 2	R3BUn/o	Used with R3 for load operation only. R101-4 points hold R3.
3B	Pick R104 and R9 rewind status	R101-5n/o	Used for rewind operation after the load operation.
1B	Pick R2 and R120 clutch status 1 and 2	R3BLn/o and R4BLn/c	
3D	Drop DP3, caps mtrs	R2AUn/c	
Systems 02.03.1	Full power applied to the left stop clutch	R1BUn/o R2ALn/o	Tape-in-cols is now under control of the take-up motor, waiting to go into the unload condition.

Location on Chart 1	Sequence of Operations	Conditions	Remarks
	Full power applied to right stop clutch	R1BLn/o R2BUn/o	
4D	Shunt load point and tape indicator lamps Tape break lamp lights	R120-3n/o	Tape break lamp is lit going into, and in, an unload condition.
Systems 02.04.1	Caps mtrs stop	DP3 points open	Capstans begin retracting because of pressure exerted by a spring on the rotor.
3C	Caps-out switches open	Caps moving in	
3D	Drop R117	Caps-out switches open	
3B	Drop DP7, take-up motors rev	117-1n/o	Take-up motors will operate to take head assembly up and pull tape from cols.
3C	Caps-in switches close	Caps fully retracted	
1D	Pick R119, manual go	Caps--in switches closed R120-4n/o	
3D	Manual go line up	R119-1n/o	Moving pulleys away from stop caps--in lowest position because caps are retracted.
3D	Pick DP6 tape take-up motors	Caps-in switches closed	Tape is pulled from cols.
3C	Tape-in-col switches close	Tape out of cols	
3D	Pick R5 and R6 tape out of col relays	Tape-in-col switches closed	
2D	Pick DP8 head take-up motor	R5BUn/o or R6BUn/o	Upper head assembly rises.
2C	Head down switch closes	Head going up	
2C	Head up switch transfers	Head near upper limit	

Location on Chart 1	Sequence of Operations	Conditions	Remark
2D	Drop DP8 head take-up motor	Head up switch n/c points open	Head fully raised.

The tape unit is now in the unload condition waiting for high-speed rewind to start. The unload condition differs from the unload status in that the vacuum motors and reel drive motors are not stopped. An unload status is the completion of an unload operation. The unload condition appears as the unload status, but does not remain so at the end of the high-speed rewind operation.

2D	Pick R113 H-S Rew status	Head up switch n/o points closed	Remove brake from right reel.
2D	Pick R114 H-S rew interlock	R113-2n/o	
Systems 02.03.1	Release brake on right and left reels	R113-1n/c P114-2n/c	Left reel driven by H-S rew motor thru direct drive.
2D	Pick DP5 H-S rew motor	Head up sw n/o points closed	
Systems 02.04.1	H-S Rew motor starts	DP5-A,B	Tape starts rewinding at H-S (approximately 500 inches/sec average).

When enough tape has been removed from the machine reel to permit the beam of the high-speed rewind area photo lamp to strike its photo cell, R121 is dropped. Dropping of R121 causes the drive to start a low-speed rewind. The lamp beam is adjusted to strike the photo cell when there is one-half inch of tape left on the machine reel.

4C	Drop R121, high-speed rewind area	High-speed rewind lamp beam strikes photo cell, cutting off conduction of RDB09 (Systems 01.09.1)	One-half inch of tape left on the machine reel.
3B	Pick R4, high-speed rewind end 1, and take-up mtrs reverse DP7	R121-1n/c	
1B	Pick R8, time delay motor	R4AUn/o	
1D	Drop R119 man go	R8ALn/c	

Location on Chart 1	Sequence of Operations	Conditions	Remarks
3D	Drop manual go line	R119-1n/c	
2D	Drop D5, rewind motor, and R113, high-speed rewind status	R121-3n/o	
Systems 02.04.1	Start time delay mtr	R8AUn/o	Timer provides time interval to allow the reels to coast to stop before starting the load operation.
Systems 02.04.1	Rewind mtr stops	DP5-A,B	Power removed from rewind mtr.
	Apply one-half power to right stop clutch (02.03.1)	R113-1n/c	One-half power is applied to right clutch to slow reels to a stop.

The half power to the right stop clutch is adjusted so about 1/16 inch of tape remains on the machine reel after it coasts to a stop.

3D	Time delay points open	Switch operated by motor	Set time has elapsed (adjusted to open approx. 1 second after reels have stopped rewinding full reel of tape).
2D	Drop R114, high-speed rewind interlock	Time delay points	
Systems 02.03.1	One-half power to left stop clutch	R114-2n/c	One-half power needed for the load operations.
3D	Pick DP6 tape take-up motor start	Time delay switch	Tape starts into cols.

From this point on, the sequence of events is identical to low-speed rewind (Section 7.1.00). The operation ends when the load point is reached.

7.4.00 REWIND AND UNLOAD (729 II AND IV ONLY)

Through a program instruction rewind and unload, the 729 II and IV tape units can be made to automatically rewind and unload as a single operation. The program instruction conditions a "rewind-unload" line in the external tape control, which latch picks R123 in the tape unit (729 II and IV Systems 01.09.1). The purpose of R123 (rewind-unload) is to remember to do an unload operation as soon as the rewind is completed.

When R123 picks, the R123-3n/c points open, producing a +W level (0 volts) on the "rewind-unload" line (Systems 02.01.1) which pick relay R111 (rewind pickup) through a relay driver (Systems 01.09.1). R111 initiates a normal rewind operation which ends when the tape reaches load point. The rewind operation was described previously.

As the load point relay R116 latch picks, the R116-4n/o points close (Systems 02.02.1) picking R107 (unload 1) through the R123-1n/o points (R123 was latch picked as a result of program instruction rewind and unload).

R107 initiates a normal unload operation. R123 is latch tripped at the start of the unload operation when R122 (unload 3) is picked (02.02.1).

7.4.01 Rewind and Unload Sequence

Chart 1, Chart 5 and the 729 II and IV tape unit Systems will be used for the following operations. It is assumed that the selected tape unit is loaded and in the high-speed rewind area prior to the execution of the rewind and unload instruction.

Location on Chart 1	Sequence of Operations	Conditions	Remarks
Systems 01.09.1	+P level on "rew unload" line	Result of programmed instruction	
01.09.1	"Rew-unload" PU	Tape unit must be selected	
4C	Latch pick R123 Rew-unload relay	Thru relay driver (Systems 01.09.1)	
2B	+W "rew-unload"	R123-3n/c	
Systems 01.09.1	"Rew PU"	"Sel and Ready" and "rewind-unload"	
4C	Pick R111 rew PU	Thru relay driver (Systems 01.09.1)	
4D	Pick R3 load rew 1	R111-1n/o	Starts rew sequence.
4D	Pick R101 load rew 2	R3BUn/o	
3B	Pick R104 and R9 rew status 1 and 2	R101-2n/o	Tape unit start H-S rew
Systems 01.09.1	"Act sel and rew"	Selected and in rew status	Response to external control.
4C	Latch pick R116 load point relay	Reflective spot on tape	At this point a normal rew has been completed and tape is at load point.

Location on Chart 1	Sequence of Operations	Conditions	Remarks
4B	Latch pick R107 unload 1	R116-4n/o R123-1n/o	Tape starts normal unload sequence.
3D	Pick R102 and R122 unload 2 and 3	R107-3n/o	
1D	Latch trip R123 rew unload relay	R123-2n/o R122-4n/o	R123 is dropped as soon as unload operation starts.
2D	Latch pick R109 unload stop	R102-3n/o Head-up sw	Unload operation complete.

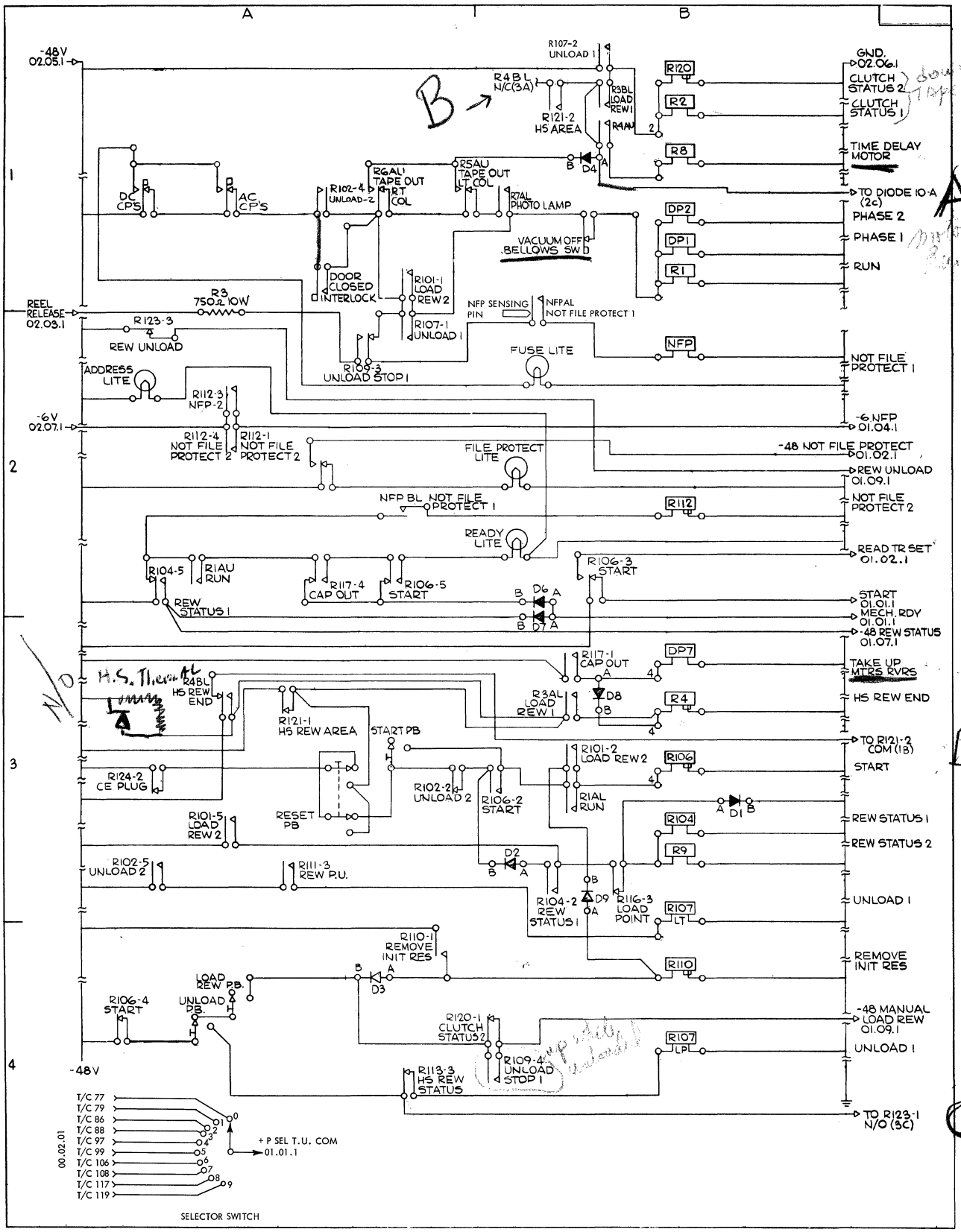

A
B
-48V 02.05.1
R107-2 UNLOAD 1
R4BL N/C(3A)
R3BL LOAD REW 1
R121-2 HS AREA
R4AU
R120
R2
R8
GND. 02.06.1
CLUTCH STATUS 2
CLUTCH STATUS 1
TIME DELAY MOTOR
TO DIODE 10-A (2c)
PHASE 2
PHASE 1
RUN
DC CPS
AC CP'S
R5AL TAPE OUT RT COL
R5AU TAPE OUT LT COL
R102-4 UNLOAD-2
R7AL PHOTO LAMP
VACUUM OFF BELLOWS SW D
DP2
DP1
R1
DOOR CLOSED INTERLOCK
R101-1 LOAD REW 2
R107-1 UNLOAD 1
NFP SENSING PIN
NFPAL NOT FILE PROTECT 1
REEL RELEASE 02.03.1
R3 750Ω 10W
R123-3 REW UNLOAD
R109-3 UNLOAD STOP 1
FUSE LITE
NFP
NOT FILE PROTECT 1
ADDRESS LITE
R112-3 NFP-2
-6V 02.07.1
-6 NFP 01.04.1
R112-4 NOT FILE PROTECT 2
R112-1 NOT FILE PROTECT 2
-48 NOT FILE PROTECT 01.02.1
FILE PROTECT LITE
REW UNLOAD 01.09.1
NFP BL NOT FILE PROTECT 1
R112
NOT FILE PROTECT 2
READY LITE
READ TR SET 01.02.1
R104-5 R1AU RUN
R117-4 CAP OUT
R106-5 START
R106-3 START
D6
D7
REW STATUS 1
START 01.01.1
MECH. RDY 01.01.1
-48 REW STATUS 01.07.1
R117-1 CAP OUT
DP7
TAKE UP MTRS RVRS
H.S. Therm
R4BL HS REW END
R121-1 HS REW AREA
START PB
R3AL LOAD REW 1
D8
R4
HS REW END
TO R121-2 COM (1B)
R124-2 CE PLUG
R101-2 LOAD REW 2
R106
START
R102-2 UNLOAD 2
R106-2 START
R1AL RUN
D1
R101-5 LOAD REW 2
RESET PB
R104
REW STATUS 1
R9
REW STATUS 2
R102-5 UNLOAD 2
R111-3 REW P.U.
D2
R104-2 REW STATUS 1
D9
R116-3 LOAD POINT
R107 LT
UNLOAD 1
R110-1 REMOVE INIT RES
R110
REMOVE INIT RES
LOAD REW PB.
UNLOAD PB.
D3
R106-4 START
R120-1 CLUTCH STATUS 2
-48 MANUAL LOAD REW 01.09.1
R107 LPL
UNLOAD 1
-48V
R109-4 UNLOAD STOP 1
R113-3 HS REW STATUS
TO R123-1 N/O (3C)
T/C 77
T/C 79
T/C 86
T/C 88
T/C 97
T/C 99
T/C 106
T/C 108
T/C 117
T/C 119
00.02.01
+ P SEL T.U. COM 01.01.1
SELECTOR SWITCH

CHART 1A

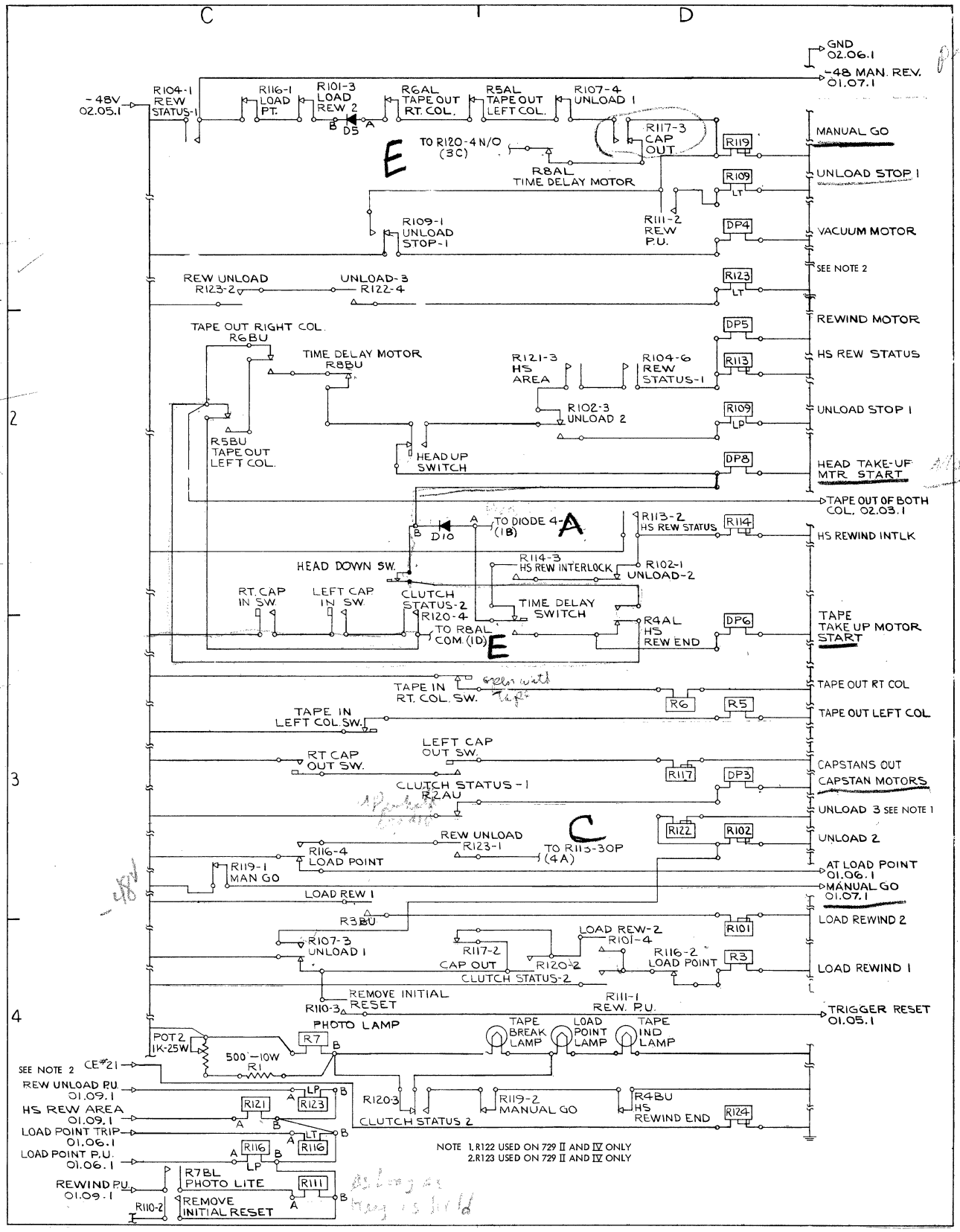

C
I
D
GND 02.06.1
-48 MAN. REV. 01.07.1
-48V 02.05.1
R104-1 REW STATUS-1
R116-1 LOAD PT.
R101-3 LOAD REW 2
D5
R6AL TAPE OUT RT. COL.
R5AL TAPE OUT LEFT COL.
R107-4 UNLOAD 1
R117-3 CAP OUT
R119
MANUAL GO
TO R120-4 N/O (3C)
R8AL TIME DELAY MOTOR
R109
LT
UNLOAD STOP 1
R109-1 UNLOAD STOP-1
R111-2 REW P.U.
DP4
VACUUM MOTOR
SEE NOTE 2
REW UNLOAD R123-2
UNLOAD-3 R122-4
R123
LT
REWIND MOTOR
TAPE OUT RIGHT COL. R6BU
TIME DELAY MOTOR R8BU
DP5
R121-3 HS AREA
R104-6 REW STATUS-1
R113
HS REW STATUS
R102-3 UNLOAD 2
R109
LP
UNLOAD STOP 1
R5BU TAPE OUT LEFT COL.
HEAD UP SWITCH
DP8
HEAD TAKE-UP MTR START
TAPE OUT OF BOTH COL. 02.03.1
TO DIODE 4-A (1B)
D10
R113-2 HS REW STATUS
R114
HS REWIND INTLK
HEAD DOWN SW.
R114-3 HS REW INTERLOCK
R102-1 UNLOAD-2
RT. CAP IN SW.
LEFT CAP IN SW.
CLUTCH STATUS-2 R120-4
TIME DELAY SWITCH
TO R8AL COM. (1D)
R4AL HS REW END
DP6
TAPE TAKE UP MOTOR START
TAPE IN RT. COL. SW.
R6
R5
TAPE OUT RT COL
TAPE OUT LEFT COL
TAPE IN LEFT COL. SW.
LEFT CAP OUT SW.
RT. CAP OUT SW.
R117
DP3
CAPSTANS OUT
CAPSTAN MOTORS
CLUTCH STATUS-1 R2AU
UNLOAD 3 SEE NOTE 1
R122
R102
UNLOAD 2
REW UNLOAD R123-1
TO R113-3OP (4A)
R116-4 LOAD POINT
R119-1 MAN GO
AT LOAD POINT 01.06.1
MANUAL GO 01.07.1
LOAD REW 1
R3BU
R101
LOAD REWIND 2
R107-3 UNLOAD 1
R117-2 CAP OUT
LOAD REW-2 R101-4
R120-2 CLUTCH STATUS-2
R116-2 LOAD POINT
R3
LOAD REWIND 1
REMOVE INITIAL RESET R110-3
R111-1 REW. P.U.
TRIGGER RESET 01.05.1
PHOTO LAMP
TAPE BREAK LAMP
LOAD POINT LAMP
TAPE IND LAMP
POT 2 1K-25W
R7
500 -10W R1
SEE NOTE 2
CE#21
REW UNLOAD P.U. 01.09.1
HS REW AREA 01.09.1
LOAD POINT TRIP 01.06.1
LOAD POINT P.U. 01.06.1
REWIND P.U. 01.09.1
R121
R123
R116
R7BL PHOTO LITE
R111
REMOVE INITIAL RESET
R110-2
R120-3
CLUTCH STATUS 2
R119-2 MANUAL GO
R4BU HS REWIND END
R124
NOTE 1. R122 USED ON 729 II AND IV ONLY
2. R123 USED ON 729 II AND IV ONLY

CHART 1B

R7

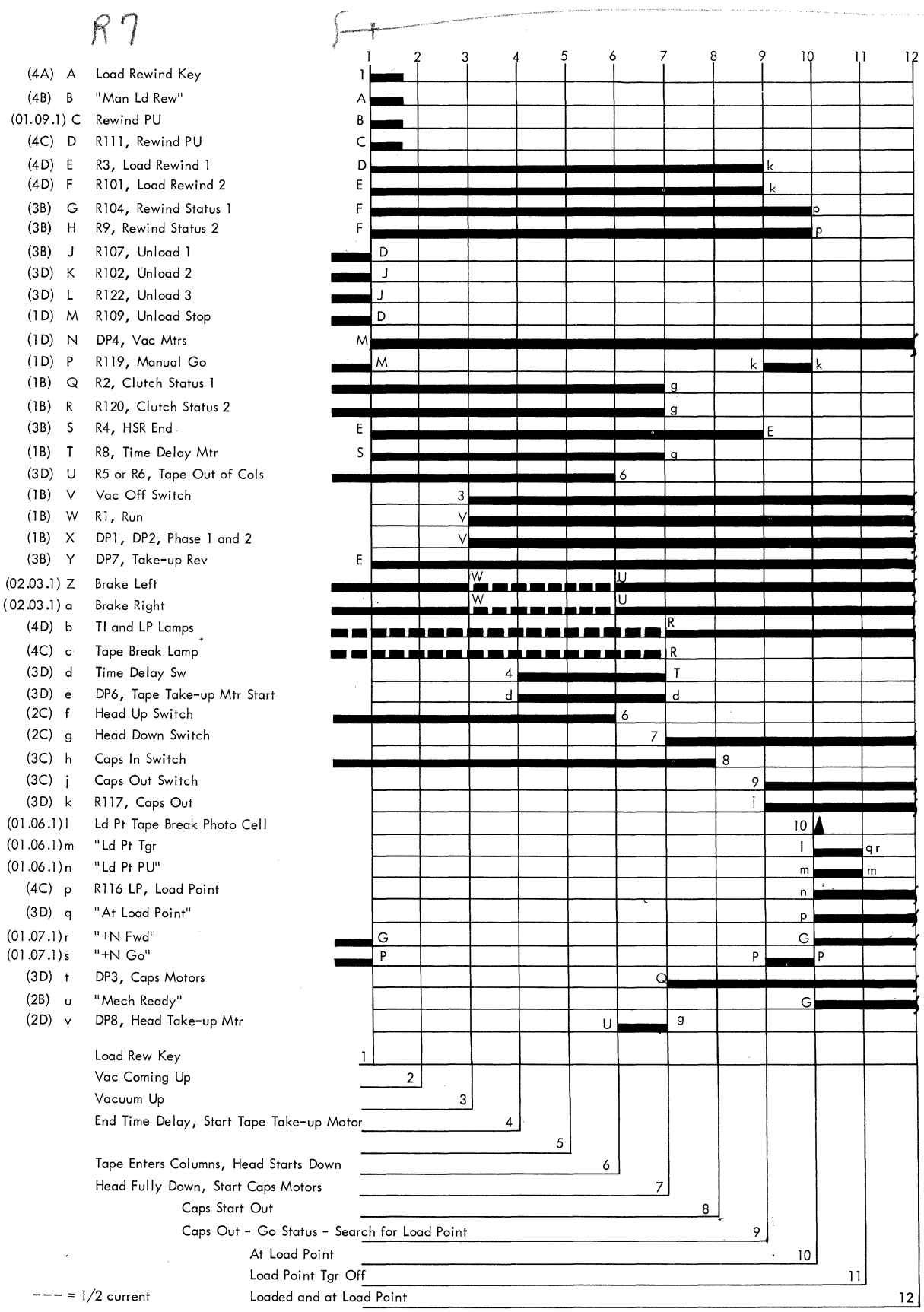
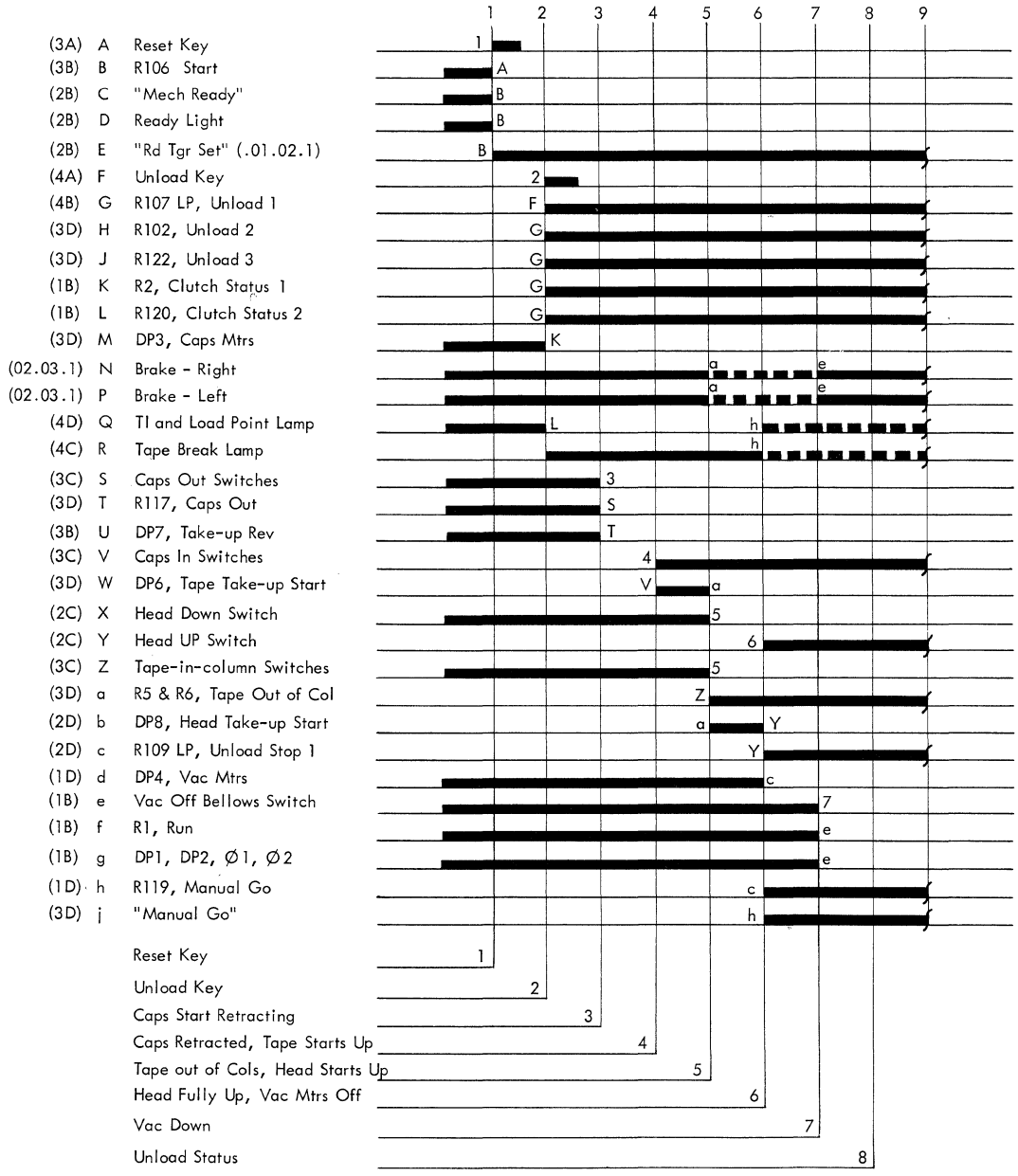


CHART 2. MANUAL LOAD REWIND, 729 II, III, IV



– – – – = 1/2 Current R110 is up throughout sequence

CHART 3. MANUAL UNLOAD, 729 II, III, and IV

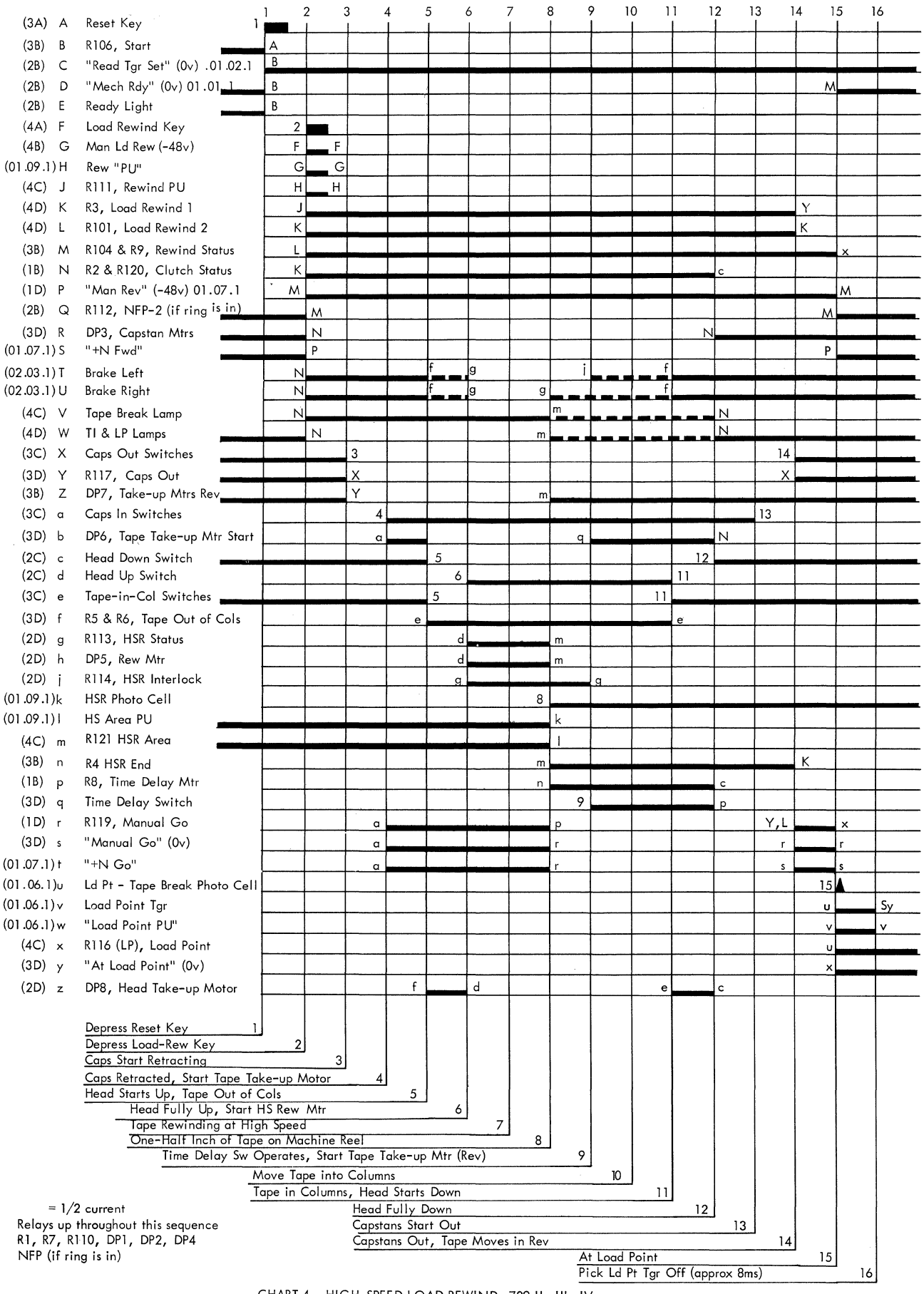
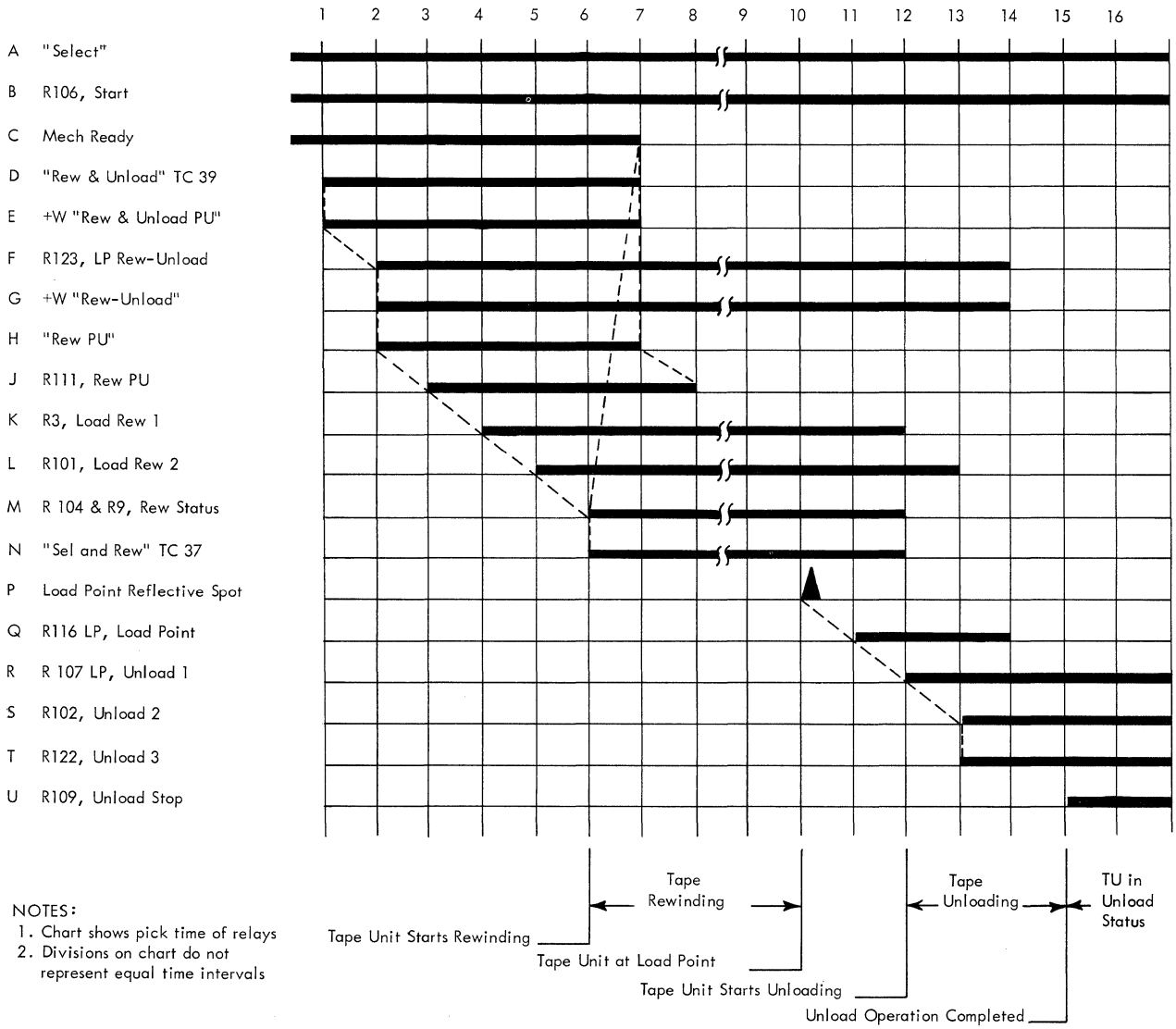


CHART 4. HIGH-SPEED LOAD REWIND, 729 II, III, IV
(Manual Operation; Tape Is Loaded, in High-Speed Area, and Ready



NOTES:
1. Chart shows pick time of relays
2. Divisions on chart do not represent equal time intervals

CHART 5. REWIND AND UNLOAD (729 II and IV ONLY)

8.0.00 TAPE UNIT LOGIC

8.1.00 SYSTEMS DIAGRAMS

Two sets of systems are included in Section 12.0.00 of this manual. One set covers the 729 II and IV; the other covers the 729 III. In general, the logic for the three units is similar, with only minor differences between the 729 II and IV and the 729 III.

Both sets of systems include charts and diagrams for locating transistor cards and other components. The systems in this manual, however, should not be used when servicing a tape unit because they may be at an earlier engineering level than the tape unit being serviced.

8.2.00 CIRCUITS AND LINES

8.2.01 Select and Ready

A tape unit is ready for selection when these conditions exist: tape unit in load status, reel door interlock closed, tape unit not in rewind status, and start key depressed. These conditions are indicated by "start" and "mech ready" lines on Systems 01.01.1.

"Sel TU" is + P level when the external select line corresponding to the setting of the select switch is at an up level. "Sel TU" causes the select light to come on regardless of the ready condition.

"Sel TU" and "start" are plus AND'ed to produce "act select"

"Act select" and "mech ready" are plus AND'ed to produce "sel + ready"

8.2.02 Read-Write Status (Systems 01.02.1)

Set Read Status. "Set Read" is externally generated and combined in a + AND circuit with "sel + ready." The resulting up level turns off the write status trigger. The status of this trigger determines whether the tape unit is in read or write status. If the trigger is off, the tape unit is in read status. Because the write status trigger is a -T, the in-phase outputs will be up when the trigger is off. Note: A current switching trigger is ON when its in-phase output lines agree with the sign of the trigger.

The in-phase output of the write status trigger is plus AND'ed with "sel + ready" to produce "sel ready + read." The "sel ready + read" line is returned to the external control as an indication that the tape unit is selected, ready, and in read status.

The write status trigger is reset to read status whenever the tape unit is under manual control. This is done by the "read trigger set" line originating on Systems 02.01.1. This line is +W level when the start relay R106 is down. The write status trigger is also set to read status during a programmed rewind by "set read" which originates in the external control unit.

Set Write Status. "Set write" is externally generated. It combines with "sel + ready" and "not file protect" in a minus AND circuit. The output of this AND circuit turns on the write status trigger. An in-phase output of the write status trigger is AND'ed with "sel + ready" to produce "write status" and "sel ready + write". "Sel ready + write" is returned to the external control to indicate that the tape unit is selected, ready and in write status.

8.2.03 Tape Indicator (Systems 01.05.1)

The tape indicator is a trigger that may be used to indicate certain conditions sensed within the tape unit. It may be controlled externally or internally. The trigger is turned on internally by sensing the reflective spot at the end of a reel of tape when writing. The rear photo cell output is coupled to a converter. The output of the converter is minus AND'ed with "NFP", and "write status" to turn on the tape indicator trigger.

The TI trigger may also be turned on by bringing up the "turn on tape indicator" line from the external control if the "act sel" line is conditioned. The out-of-phase output of the TI trigger turns on the tape indicator light. An in-phase output of the trigger is AND'ed with "act sel" to become "act sel + TI On," which is sent back to the external control.

"Turn off TI" originates in the external control and is AND'ed with "act sel" to turn off the TI from an external source. When the TI trigger is off, an out-of-phase output is AND'ed with "act sel" to produce "act sel + TI off" which returns to the external control to indicate the status of the TI trigger.

8.2.04 Tape Break Indication (Systems 01.06.1)

When the tape unit is rewinding at high speed and a tape break occurs, the operation is stopped by the load point photo cell and associated circuits. A light source is located beneath the tape; its beam falls on the load point photo cell when the tape is broken. This light is mechanically aligned to the photo cell when the upper head assembly is raised (Figure 4.3-4).

The output of the load point photo cell is AND'ed with "reverse" to turn on the load point trigger. An output from this trigger is used to latch pick the load point relay R116. (Only an unload operation causes this relay to be latch tripped for this condition.) The load point trigger is turned off by the output of an AND circuit whose inputs are "fwd" and "at load point."

Picking R116 causes R3 to be dropped; R3 in turn drops R101 (Systems 02.02.1), R12 and R120 (Systems 02.01.1). Dropping R101 causes R1, DP1 and DP2 to drop because R5 and R6 bypass points are picked (tape out of columns) during a high-speed rewind. Dropping R1 applies full brake to both reels (Systems 02.03.1); DP1 and DP2 drop power to all of the motor circuits except the fan, blower and vacuum motors.

Dropping R120 causes R119 to drop opening "manual go". In this condition there is no way to bring up "manual go" needed to latch trip R116 except by starting an unload operation. When the unload key is depressed, R107-2 points pick R2 and R120. R120-4 points complete a path to R119. "Manual go" comes up producing "+N go" which is AND'ed with "at load point" to latch trip R116. The unload operation is now complete.

8.2.05 Starting from Load Point (01.06.1)

To read or write from the beginning of the tape, +N GO must be brought up. This is done either by "GO" when the tape drive is controlled by the external source (Systems 01.07.1) or by "manual GO" (when under manual control or when the CE switch is used.)

+N GO combines with "at load point" (Systems 01.06.1) to latch trip the load point relay R116. "At load point" and "act sel + at load point" drop when R116 is dropped.

8.2.06 Start, Stop, and Reverse Control (Systems 01.07.1)

There are two ways to bring up "+N GO." "GO," brought up externally, combined with "select and ready," raises +N GO and drops "+N STOP". Also, raising "manual go" combined with "not pick load point" raises "+N GO".

There are two ways to bring up "reverse," conditioning the tape unit to move tape in a reverse direction. "Backward," generated externally, combined with "select and ready" produces "reverse" (Systems 01.07.1).

"Manual reverse" (Systems 02.02.1) also brings up "reverse."

8.2.07 Read Preamplifier

Each of the seven read coils is connected to the input of its respective amplifier (Systems 01.03.1). As bits are read they are amplified in the preamplifier and fed to the read bus through an emitter follower output stage.

The signal level at the read coil is about 15 mv peak-to-peak. The output level of each pre-amp is adjusted to 8v peak-to-peak by a potentiometer controlling the feedback from the third stage.

The 8v peak-to-peak signal feeding the emitter follower output stage swings above and below approximately zero, or ground level.

The input to the emitter follower is controlled by "sel + ready" through a transistor gate circuit. When "sel + ready" is up, the gate transistor is reverse biased and looks like a very high resistance across the input to the emitter follower. When "sel + ready" is down, the gate transistor is forward biased, causing it to conduct heavily. This effectively connects the base of the emitter follower to +6v through the low resistance of the conducting gate transistor shunting out any noise signals reaching the output of the preamplifier. A 12-section lumped constant delay line is inserted between the third stage of the preamp and the emitter follower. This delay line provides adjustable delay in increments of .25 microsecond to compensate for skew caused by slight misalignment of the read coils during manufacture of the head assembly.

8.2.08 Writing on Tape (Only One-Bit Position Considered)

Review the method of storing information. Note that tape is magnetically saturated in a predetermined direction by passing current through the write coil in one direction. Current flow is reversed under control of the write trigger. Current is always flowing through the write coil when the tape unit is in write status with "not file protect" at -6v level (Systems 01.04.1).

The emitter follower outputs of the write trigger are fed to a head driver. The collector loads for this driver are the two halves of the write coil. Because either emitter follower output of the write trigger is always at -6v when the tape unit is in write status, the respective side of the head driver is conducting, causing current to flow in the associated coil.

The write trigger is flipped by the positive shift of a "write pulse" applied to its binary input. Write pulses originate in the external control and have a repetition rate and pulse duration determined by the type of tape unit employed. Write pulses for the 729 II tape unit occur every 67.2 microseconds and have a duration of 8.4 microseconds. Write pulses for the 729 III and IV occur every 16 microseconds and have a duration of 1 microsecond.

Before write pulses can flip the trigger it is necessary for the trigger to be conditioned by an up level on its gate. The condition of the trigger gate is determined by the level of the write bus.

When the write bus is at a -N level the write trigger gate is up (0 volts) and the trigger is conditioned so it will flip when the write pulse occurs. A + N level on the write bus (no information) causes the trigger gate to be down (-12v), thus preventing the write trigger from being flipped by a write pulse.

The head driver circuit is conditioned by "write status" and "not file protect." The head driver can conduct and thus pass current through the write head only when the tape unit is in write status and not file protected.

When a character is written on tape, the bits must be written in a straight line across the tape. Any deviation from this pattern is called skew and must be held to a minimum. There are two methods of obtaining minimum skew. One is by mechanical adjustment to position the head assembly parallel to the tape. The remaining skew is due to slight misalignment of the individual write coils which make up the head assembly and is adjusted to a minimum by electronic delay inserted between the sample pulse line and the write triggers. The delay is obtained from a distributed constant delay line of twelve .18-microsecond sections. By selecting the proper tap on the delay line for each of the seven tracks, all bits for a character will be written in a straight line across the tape even though the physical position of the write head gaps may not be in a straight line. There are seven such circuits, one for each of the seven tracks.

8.2.09 Write Echo (Systems 01.04.1)

For checking purposes, a write echo pulse is developed for any track in which a bit is written. Echo pulses are generated in the head driver circuit. When a bit is written, current is switched from one half of the write coil to the other half. This

is accomplished by cutting off the transistor in series with one half of the coil while, at the same time, driving into full conduction the transistor is series with the other half of the coil. There will be a 6v negative shift at the collector of the transistor which is driven to cut-off. This negative shift is capacity coupled to the base of a PNP transistor causing it to conduct momentarily. This produces a positive pulse which is fed to the echo bus and returned to the external control.

8.2.10 Writing a Check Character (LRCC)

Because the write trigger for each track is turned alternately on and off to write 1 bits, the state of the trigger at the end of a block of information indicates whether an odd or even number of 1's has been written. If an even number of 1's has been written, the write trigger is off; if an odd number has been written, the write trigger is on.

After writing a block of information, all the write triggers receive a reset pulse. Only the triggers that were on are turned off, thereby writing a 1 bits on the tape. The character written, as a result of resetting the write triggers, is called the longitudinal redundancy check character (LRCC). The LRCC is used during reading of this block of information from tape to detect the dropping or picking up of 1 bits in any track.

A line referred to as "write check character" is routed to the tape unit from the external control. This line is normally at + N level. When it drops to -N level the write triggers are reset.

8.2.11 Rewind (Systems 01.09.1)

A rewind operation may be started in two ways. One way is by "start rewind" from an external source, which combines with "select + ready" to form "rewind PU". This line picks R111 to initiate a rewind operation. During the rewind operation, R104 is picked and "rewind status" is conditioned (Systems 02.01.1). This line is -AND'ed with "active sel" to form "select + rewind status," which is sent back to the external control as an indication that this operation is taking place.

The other way to start a rewind operation is from the load-rewind key on the tape unit panel. This key (Systems 02.01.1) conditions "manual load rewind" which is minus AND'ed with "read status" (Systems 01.09.1) to produce "rewind PU". "Read status" is used because if the tape unit was in write status, the write coils would conduct, destroying information as the tape passed over the head.

8.2.12 File Protection Circuit

The file protection system is provided to prevent accidental writing on master tapes (See also Section 4.11.0). When a reel containing the plastic ring is mounted on the file reel hub, a sensing pin which protrudes from the front of the tape unit above the hub is depressed.

The sensing pin operates the "not file protect 1" relay armature. The NFP AL points close, energizing the NFP1 relay (Systems 02.01.1). This action causes the armature to complete its travel, pulling the sensing pin away from the plastic ring

to keep the pin from dragging on the plastic ring when the reel revolves. The NFP1 relay remains energized as long as the reel is on the tape unit and the tape unit door is closed. The NFP BL points close (Systems 02.01.1) to complete a circuit to pick R112 "not file protect 2."

R112-1n/o points close to condition a line "-48v NFP." R112-2 and 3 n/o points close to condition a line "-6v NFP." "-48v NFP" becomes "-W NFP" (Systems 01.02.1) and is combined with "sel + ready and "set write" to turn on the write status trigger. Note that R112, NFP 2 must be energized before the write status trigger can be turned on.

"-6v NFP" (Systems 02.01.1) supplies voltage to the center tap of the write coils. R112 remains energized as long as the "file protect 1" relay is energized and the tape unit is not in rewind status.

During a rewind operation R104 "rewind status 1" is energized and the R104-5n/c points open preventing R112 from being energized. With R112 de-energized the NFP lines are de-energized eliminating the possibility of the tape unit being in write status.

8.2.13 Start Key--Mechanically Ready

To place the tape unit under external control, the start key must be depressed (Systems 02.01.1). This energizes the start relay R106. The R106-4 n/c points open, making the load and unload key inoperative. R106-3n/c points open, placing the "start" line (Systems 02.01.1) at + W level (0 volts).

"Mechanically ready" (Systems 02.01.1) is raised to + W level when R106-5 n/c points open if R1 and R117 have previously been energized and R104 is de-energized.

When picked, R1 indicates a closed door, circuit protectors all closed, no burned out lamps, tape not broken, DC power available, and sufficient vacuum.

R117, when energized, indicates both capstans out. R104 de-energized indicates the tape unit is not in rewind status.

"Start" is combined with "select" (Systems 01.01.1) to produce "active select."

"Mechanically ready" is combined with select (Systems 01.01.1) to produce "select + ready."

8.2.14 Reset (02.01.1)

Depressing the reset key opens the hold circuit to R106, taking the tape unit out of the ready status. The reset key stops any operation that has been started except load and unload operations. R106-5 dropping "mechanically ready," eliminates most external controls.

The reset key opens the hold circuit for R104 and R9, rewind status 1 and 2, stopping a low-speed rewind operation. If the tape unit is in a high-speed rewind operation, the reset key shunts the R121-1 points, high-speed rewind area, causing the drive to load tape. If the key is held depressed, the drive will stop after the tape is loaded. R104 and R9 cannot be energized after R101-5 is dropped at the completion of the load operation.

If the reset key is depressed and released during a high-speed rewind operation, the tape unit causes tape to load, and then starts a low-speed rewind operation. Tape will rewind to load point, unless the reset key is again depressed. The reset key does not reset the tape indicator.

8.2.15 Anti-Spill Device

During the transfer from a high-speed to a low-speed rewind, the time delay allows the reels to coast to a stop before loading the tape. The time delay points are set to close about one second after the reels stop, when rewinding a full reel of tape. Because high-speed rewind will not always involve a full reel of tape, the reels may stop long before time delay points close. Because the file reel brake is not applied until the time delay has elapsed, it will be free-wheeling between the times when it stops and the brake is applied. This free-wheeling allows for the possibility of an improper load operation by dropping tape into either column and allowing it to be drawn to the bottom.

A circuit has been set up to eliminate this condition. R114 is picked at the start of a high-speed rewind by R113-2 (Systems 02.02.1) and held through its own points until the time delay points open. R114-2 points (Systems 02.03.1) are transferred, removing the one-half brake from the file reel. The n/o point is brought to the n/c R5BU and R6BU points (Systems 02.02.1) in parallel. These points are open because tape is out of the columns during high-speed rewind.

If tape should be dropped into either of the columns, the associated n/c points return to normal, applying current to the file-reel stop clutch as long as R114 is picked.

8.2.16 Dual Density -- 729 II & IV Only (Systems 01.02.2)

The control unit used with the 729 II and IV tape units is capable of writing tapes of low density (200 characters per inch) or high density (555 characters per inch). The density of writing on tape is controlled by the frequency of the write pulses generated in the control unit.

A density trigger in each tape unit determines the density at which a particular 729 II or IV tape unit is to write. The output of the density trigger is AND'ed with "act select" and is sent to the control unit to select the proper write pulse frequency.

When the output of the density trigger is a +P level, tape is written at high density. A - P level causes low density writing. Note that the density trigger does not directly affect the operation of any circuit in the tape unit. It serves only as a memory trigger.

The status of the density trigger can be set manually by depressing the change density key on the tape unit operator panel (Figure 4.14-1B). The change density switch applies a voltage shift to a binary input to the density trigger. Each time the key is depressed, the status of the density trigger changes.

The status of the density trigger can also be set by programmed instructions set hi density and set lo density. These program instructions produce changes in line levels, which are sent to the tape unit where they are AND'ed with "act sel" to set the density trigger.

The status of the density trigger can be determined visually by indicator lights on the tape unit operator panel.

8.2.17 Mechanical Counters

Two mechanical counters (Systems 01.10.1) are in the 729 II, III, and IV for customer engineer use. The counters are actuated by electrical impulses and can be wired into circuits to count the number of times a particular operation occurs. Because the counter is a mechanical device, it has limited speed of operation and should be used only for checking circuits which operate at a low repetition rate such as backspace, load point and so on. The counters are located at the lower left front of the tape unit next to the vacuum column.

9.0.00 PURPOSE OF RELAY POINTS AND SWITCHES

ALL locations refer to Chart 1A and B, unless otherwise stated.

Relay 1, run relay (1B), is picked when the bellows switch closes. It senses failures such as circuit protector operation, loss of vacuum in either column, photo cell lamp failure, or bellows switch operation during a normal operation.

1AU (2A)	Completes circuit for 48 volts to "CE switch and ready;" drops "ready" in case of any of the above failures.
1AL (3B)	Drops R106 (start) for any of the above named failures.
1BU (Systems 02.03.1)	Applies full brake to the file reel when normal. N/O points complete a circuit to the R2AL points when R1 is energized.
1BL (Systems 02.03.1)	Same usage as R1BU but applied to the machine reel.

Relay 2, clutch status relay 1 (1B), is picked during rewind, load, and unload operations. When energized, it allows a circuit to be completed for half-brake on both reels. R2 points also control energizing of the capstan drive motors.

2AU (3C)	N/C points pick DP3 to allow the capstan motors to run only when R2 is down.
2AL (Systems 02.03.1)	Places file reel under control of the left vacuum column switches during normal operation.
2BU (Systems 02.03.1)	Places machine reel under control of the right vacuum column switches during normal operation.

Relay 3, load rewind 1 (4D), is picked for load operation.

3AL (3B)	Picks R4 (high-speed rewind end 1) and take-up motor reverse relay DP7.
3BU (3C)	Picks R101 (load-rewind 2).
3BL (1B)	Holds R2 and R120 when R107 is latch tripped at start of a load operation in a slow-speed area. It picks R2 and R120 at the start of a high-speed rewind operation.

Relay 4, high-speed rewind end (3B), is picked during load-rewind operations when less than one-half inch of tape is on the machine reel.

4AU (1B)	Picks R8 (time delay motor) when entering low-speed rewind area from high-speed rewind.
4AL (3D)	Completes a pick circuit for DP7 to start the tape take-up motor at the beginning of high-speed rewind operation.
4BU (4D)	Causes the load point and tape indicator lamps to come on at the start of a low-speed rewind.
4BL (3A)	Holds R4 and DP7 when entering low-speed rewind from high-speed rewind.

Relay 5, tape out of left col (3D), is picked when the left tape-in-col switch is normal.

5AU (1B)	Drops R1 (run) if tape is not in the left column during normal operation.
5AL (2B)	Drops R119 (manual go) if tape is not in left column during a low-speed rewind operation.
5BU (2C)	N/O, in pick circuit for DP8 (head take-up motor). Tape must be out of left column before entering high-speed rewind. (Pick R113 and DP5). N/C, anti-spill device one-half brake is applied to file reel if tape goes into the left column at the end of a high-speed rewind and insures proper load operations if file reel is free wheeling.
5BL (Systems 02.03.1)	Applies full brake to left reel when tape enters column while R2 is energized.

Relay 6, tape out of right column (3D) is picked when the right tape-in-col switch is operated.

6AU (1A)	Drops R1 (run) if tape is not in the right column during normal operation.
6AL (1C)	Drops R119 (manual go) if tape is not in the right column during a low-speed rewind operation.

6BU (2B)	N/O, in pick circuit for DP8 (head take-up motor). Tape must be out of right column before entering high-speed rewind (pick R113 and DP5). N/C, same as 5BUn/c except with reference to the right column.
6BL (Systems 02.03.1)	Same as 5BL points except with reference to right reel.

Relay 7, photo lamp (4C) is picked through the tape break, load point, T1 lamps when 48 volts is up. It drops as a result of a failure of any of the lamp filaments.

7AL (1B)	Drops R1, DP1, and DP2. Prevents picking R111 (rewind PU) when a photo lamp has failed.

Relay 8, time-delay motor (1B) is picked during rewind operations to start the time delay motor.

8AU (Systems 02.04.1)	Completes a circuit from phase 1 through the timer motor to phase 2.
8BU (2C)	Drops R113 when timer starts and prevents picking R23 (high-speed rewind) while timer is running.

Relay 9, rewind status 2 (3B): energized in parallel with R104 during load rewind.

9AL (Systems 02.03.1)	Prevents energizing left down clutch during load rewind. This is done to prevent dumping excessive tape in left column during the load operation.

Relay 101, load rewind 2 (4D), is picked when R3 is picked.

101-1 (1B)	Parallels R5AU and R6AU to pick R1, DP1, and DP2 during a load-rewind operation.
101-2 (3B)	Allows R106 to be picked before bellows switch operates.
101-3 (1C)	Completes a circuit to R119 (manual go) during rewind operation.
101-4 (4D)	Hold circuit for R3 during a load operation.
101-5 (3A)	Picks R9 and R104 (rewind status) at the start of a load operation.

Relay 102, unload 2 (3D), is picked when the tape unit starts an unload operation.

102-1 (2D)	Drops R114 high-speed rewind interlock if the unload key is depressed during a high-speed rewind.
102-2 (3A)	Prevents R106 from being held during an unload operation.
102-3 (2D)	N/O, causes R109 to be latch picked when the tape is out of the columns on unload. N/C, drops R113 high-speed rewind status and DP5 (rew motor) if the unload key is depressed during a high-speed rewind.
102-4 (1A)	N/O parallels door interlock switch so that tape can be unloaded with door open.
102-5 (3A)	N/O conditions circuit to latch trip R107 (unload 1) when starting load operation.

Relay 104, rewind status, (3B), is picked when the load-rewind key is depressed.

104-1 (1C)	Supplies a circuit for -48 volts to R119 and conditions "manual reverse."
104-2 (3B)	Supplies a hold circuit for R9 and R104.
104-5 (2A)	Drops "mechanically ready" to 01.01.1 and conditions "rewind status" to 01.07.1.
104-6 (2D)	Drops high-speed rewind relays when the rewind operation is reset.

Relay 106, start relay (3B), is picked when the start key is depressed and holds until the reset key is depressed.

106-2 (3B)	Hold point for R106.
106-3 (2B)	N/O removes read trigger set to (01.02.1). N/C conditions "start".
106-4 (4A)	Opens the circuit to the load-rewind switch when the tape unit is under external control.
106-5 (2A)	Brings up "mechanically ready" and turns on ready light.

Relay 107, unload I latch pick (4B) and latch trip (3B), latch picks when the unload key is depressed; it latch trips when R111 is picked for a load-rewind operation.

107-1 (1A)	Shunts R5 and D6 points during unload operation.
107-2 (1B)	Picks and holds R2 and R120 when the unload key is depressed.
107-3 (4C)	Picks R102 (Unload 2) and R122 (Unload 3). R122 is omitted in the 729III TU.
107-4 (1D)	Breaks the circuit to R119, dropping "manual go" if the unload key is depressed while in manual forward or backward-go operation.

Relay 109, unload stop latch pick (2D) and latch trip (1D), latch picks to end an unload operation when the head is up and tape is out of both columns. Latch trips when the load-rewind key is depressed.

109-1 (2B)	N/C points complete the circuit to DP4 to start vacuum motor. N/O points supply -48 volts to latch trip R109 for load rewind.
109-3 (2A)	N/O points complete circuit to pick NFP relay when reel release button is depressed; prevents bending NFP sensing pin. N/C points complete circuit to NFP relay during unload operation.
109-4 (4B)	Provides circuit for "manual load rewind" when load-rewind key is depressed.

Relay R110 remove initial reset (4B), is picked when the load rewind key is depressed or R106 (start) is picked.

110-1 (4A)	Hold for R110.
110-2 (4C)	Complete common return circuit for R111, R116, R121, R123.
110-3 (4C)	Removes trigger reset.

Relay 111, rewind PU (4C), is picked by relay driver (01.09.1).

111-1 (4D)	Completes the circuit to pick R3, starting the load-rewind operation.
111-2 (1D)	Latch trips R109 to drop the unload status.
111-3 (3B)	Latch trips R107 to drop the unload status.

Relay 112, not file protect 2 (2B), is picked when file reel is not protected. It allows tape unit to go into write status.

112-1 (2A)	N/C turns on the file protect light. N/O conditions "not file protect."
112-3 and 4 (2A)	Applies -6v to center tap of write coils.

Relay 113, high-speed rewind status (2D), is picked when the tape is out of both columns and the head is up during a high-speed rewind operation.

113-1 (Systems 02.03.1)	Opens the circuit for one-half brake on the machine reel during high-speed rewind.
113-2 (2D)	Picks R114 during the high-speed rewind.
113-3 (4A)	Allows unload operation at end of low-speed rew if R123 is picked.

Relay 114, high-speed rewind interlock (2D), is picked by R113.

114-2 (Systems 02.02.1)	Opens the circuit for one-half brake on the file reel during high-speed rewind.
114-3 (2D)	Forms holding circuit to R114 so that it may stay held longer than R113.

Relay 116, load point relay, latch pick (4C), latch trip (4C), is latch picked when the tape has reached load point during the rewind operation.

116-1 (1C)	Drops the manual go relay R119 when tape reaches load point during rewind.
116-2 (4D)	Opens the circuit to pick R3 if tape is at load point.
116-3 (3B)	Drops R9 and R104 (rewind status) when load point is reached during a rewind operation.
116-4 (1A)	N/C brings up "at load point" to 01.06.1. N/O starts unload operation when tape reaches load point if R123 is picked.

Relay 117, capstans out (3D), is picked when the left and right capstan out switches are closed, indicating that both capstans are extended.

117-1 (3B)	Provides a parallel circuit to keep DP7 energized.
117-2 (4D)	Drops R3 at end of load operation.

117-3 (1D)	In pick circuit for R119.
117-4 (2A)	N/O completes circuit to ready light. N/C conditions circuit to bring up "mechanically ready."

Relay 119, manual go (1D), is picked during any manual operation: load, rewind, unload, and CE manual operation.

119-1 (3C)	Brings up "manual go."
119-2 (4D)	Open circuit around load point and tape indicator lamp.

Relay 120 (1B), clutch status 2, is picked during rewind, load, and unload operations.

120-1 (4B)	Conditions "manual load rew" when load-rewind key is depressed.
120-2 (4D)	Forms a hold circuit for R3 (load-rewind 1) at the beginning of a load operation.
120-3 (4C)	N/C opens circuit around tape break lamp during load and unload operations. N/O sets up circuit around load point and tape indicator lamps during load and unload operations.
120-4 (2C)	N/O completes circuit to tape take-up motor during load and unload operations.

Relay 121 (4C) high-speed rewind area, is picked when the machine reel contains sufficient tape (one-half inch or more) to block the light to the high-speed-rewind area photo cell.

121-1 (3A)	Picks high-speed-rewind end relay, R4, to start low-speed rewind.
121-2 (1B)	Prevents dropping R2 and R120 during high-speed rewind if tape unit door is opened..
121-3 (2D)	Completes circuit to R113 H-S Rew status and DP5 rew motor.

Relay 122, unload 3 (3D) (729 II and IV only), is picked along with R102, unload 2, during an unload operation.

122-4 (1C)	Completes circuit to latch trip R123 at beginning of programmed unload operation.

Relay 123, rew and unload (729 II and IV only), latch pick (4C), latch trip (1D) is picked as a result of rew and unload program instruction. R123 initiates an automatic unload operation after rewind.

123-1 (3C)	Completes circuit to pick R107 when tape reaches load point after rewind. R107 starts unload operation.
123-2 (1C)	Conditions circuit to its own latch trip coil through R122-4. R123 will be latch tripped at start of unload operation.
123-3 (2A)	Conditions "rew and unload" which is used to condition circuit to start rewind (01.09.1).

Relay 124, CE plug relay (4D), is picked when CE plug is inserted.

124-2 (3A)	N/C points open circuit to start and reset keys (02.01.1). The functions of these keys is transferred to the CE box while R124 is picked.

DP1, phase 1 (1B), is picked with R1 and controls phase 1 of the three-phase 208v supply. DP1 B contact is located in Systems 02.04.1.

DP2, phase 2 and 3 (1B), is picked with R1 and controls phases 2 and 3 of the three-phase 208v supply. Contacts are located in Systems 02.04.1.

DP3, capstans motors relay (3B), is picked when tape is in load status. DP3 A and B contacts (02.04.1) switch two phases of the three-phase input to the capstans motors, allowing them to operate.

DP4, vacuum motors relay (1D), is energized at start of load operation, when R109 is latch tripped. Contacts complete circuit to vacuum motor, Systems 02.04.1.

DP5, rewind motor relay (2D), is energized during high-speed rewind. DP5 A and B contacts complete circuits to rewind motor (02.04.1).

DP6, tape take-up motor start (3D), is energized during load and unload operation. Contacts complete circuit to tape take-up motor to allow tape to be put into columns during load operation or removed from columns during unload operation.

DP7, take-up motors reverse relay (3B), is picked during load operation. DP1,A and B, reverses two phases of the tape and head take-up motors to allow them to run in reverse (02.04.1).

DP8, head take-up motor relay (2D), is energized during load and unload operations. DP8 A and B contacts complete the circuit to energize head take-up motor, Systems 02.04.1.

NFP, not file protect 1 relay (1B), is energized by the sense pin which operates its armature causing the NFP AL points to complete the circuit to the relay coil. This relay is up when a plastic ring is placed in the file reel. When down, this relay prevents writing on tape.

NFP AL (2B)	Provides circuit to energize the NFP relay coil.
NFP BL (2A)	Picks R112 not file protect 2.

CP Switches (1A). When either an AC or DC circuit protector trips, the points transfer to light the fuse light. R1, DP1, and DP2 are also de-energized.

Door Closed Interlock Switch (1A). The points are shown with the door open. When the full door and the sliding panel are closed, the points transfer to supply -48 volts to R1, DP1, and DP2. Note: Opening either the full door or the sliding panel allows the switch to open.

Bellows Switch (1B). When sufficient vacuum is up, the bellows is contracted, allowing the points to return to the N/C position.

Right and Left Capstan-In Switches (3A). The shown points are N/O points of microswitches. When the capstans are in, they are closed.

Time Delay Switch (2B). The points open at the end of a determined number of seconds, set on the dial, after the timer motor starts.

Left and Right Capstan-Out Switches (3C). The shown points are N/O points of microswitches. When the capstans are out, the points are closed.

Tape-In-Column Switches Right and Left (3C). The tape-in-column switches are pressure sensitive switches mounted at the bottom of each vacuum column. When vacuum is up and tape is in the columns, the shown points are open due to the vacuum in the columns.

Unload Switch (4A). This manually operated key furnishes a circuit to latch pick R107.

Load-Rewind Switch (4A). This manually operated key applies -48 volts to "manual load-rewind" which AND's with "read status" (01.09.1) causing R111 to be picked.

Head-Down Switch (2C). The shown points are N/C points of a microswitch that opens when the head is near its lower limit.

Reset Switch (3A). This manually operated key, when depressed, causes R106 to drop.

Start Key (3A). This key, when depressed, picks R106.

Head Up Switch (2C). This switch transfers when the upper head assembly is near its upper limit. The N/O points are in the high-speed rewind circuit. The N/C points open when the switch transfers, stopping the head take-up motor.

10.0.00 RESUME OF LINES ENTERING AND LEAVING THE TAPE UNIT

Go (01.07.1)	Controls the status of the prolays. Originates in the external control source.
Backward (01.07.1 729II, IV only)	AND'ed with "select and ready" to produce "reverse" which controls the status of the prolays. The backward line is also AND'ed with "not at load point" to prevent back-spacing when the tape unit is at load point. The backward line originates in the external control.
Not Backward (01.07.1, 729III only)	Performs the same logical functions as the backward line previously described.
Select Line (02.01.0, 729II & IV) (02.02.1, 729III)	The ten select lines are routed from external control; they determine which tape unit is selected.
Select and at Load Point (01.06.1)	Generated in the tape unit and routed to the external control to indicate that the selected tape unit is at load point.
Select and Ready (01.01.1)	Routed to the external control source to indicate that the selected tape unit is mechanically and electrically ready.
Start Rewind (01.09.1)	Originates in the external control to start a rewind operation.
Select and Not at Load Point (01.06.1)	Routed from the tape unit to the external control to indicate when tape is not at load point.
Select and Rewind	This line is an output of the tape unit and indicates to the external control that the selected tape unit is rewinding.
Set Hi Density (01.02.2, 729II & IV only)	Originates in the external control and is used to set the density trigger in the selected tape unit.
Set Lo Density (01.02.2, 729II & IV only)	Sets status of tape unit density trigger to indicate that writing is to occur at low density.

Hi-Lo Density (01.02.2, 729II & IV only)	This line is the output of the density trigger in the tape unit. It is routed to the external control to indicate the density at which writing is to occur (low, 200 characters per inch; high, 555 characters per inch).
Turn off TI (01.05.1)	Originates in the external control; used to turn off the tape indicator trigger in the selected tape unit.
Sel and TI Off (01.05.1)	Response line from the tape unit to the external control to indicate status of TI trigger.
Turn On TI (01.05.1)	Originates in the external control and turns on the TI trigger in the tape unit.
Sel and TI On (01.05.1)	Response line from the tape unit indicating the status of the tape indicator trigger.
Rew and Unload (01.09.1, 729II and IV only)	Originates in the external control for the 729II and IV tape unit and initiates a rewind operation followed immediately by an unload operation.
~~Check Pulse 1 and 2~~ ~~(01.10.1)~~	Two lines originating in the external control and used to pulse mechanical counters in the tape unit. The check pulse lines can be connected to various circuits in the external control to count the number of times a particular operation or condition occurs.
Set Write Status (01.02.1)	This line is an input from the external control to turn on the write status trigger.
Sel Ready and Write (01.02.1)	Originates in the tape unit and is used to indicate to the external control that the selected tape unit is ready and in write status.
Write Pulse (01.04.1)	This is a line originating in the external control, over which timed pulses are sent to flip the write triggers.
Write Bus (01.04.1)	Seven lines make up the write bus. Information is sent over it to the tape unit to condition the write triggers.

Write Echo Pulse (01.04.1)	The echo outputs of the seven head drivers are combined in an OR circuit and sent to the external control source on the write echo pulse line to indicate that a character has been written.
Write Check Character (01.04.1)	Originates in the external control and is used to reset the write triggers after a record is written. Resetting the write triggers causes a longitudinal redundancy check character to be written on tape.
Set Read (01.02.1)	This line is an input from the external control to set the write status trigger off. This action puts the tape unit in read status.
Sel Ready and Read (01.02.1)	Response line from the tape unit indicating to the external control that the selected tape unit is mechanically and electrically ready and in read status.
Read Bus (01.03.1)	The read bus consists of seven lines over which information is transmitted to the external control during a read operation.

11.0.00 SPECIAL COMPONENT CIRCUITS

OPERATION of some transistor circuits in the IBM 729 tape units may be difficult to analyze from the systems block diagrams. This section shows these circuits in schematic form and briefly explains their operation.

11.1.00 READ PREAMPLIFIER

The input to the preamplifier (Figure 11.1-1) is a small voltage about 15-30 millivolts peak-to-peak developed across the read coil by changes in flux as bits are read from tape. The signal level fed to the external control as a result of reading a bit from tape must be 8v peak-to-peak. The overall gain of the preamplifier, therefore, must be about 500.

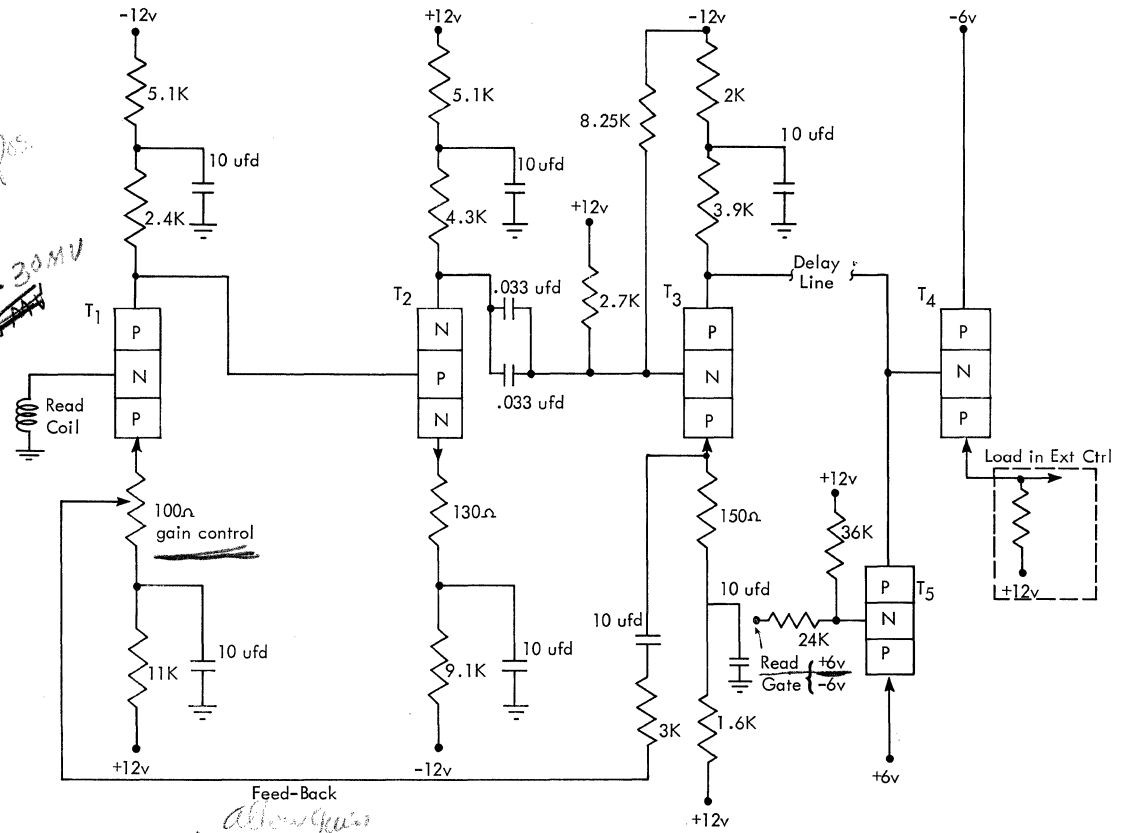


FIGURE 11.1-1. READ PRE-AMPLIFIER

When the input voltage shifts in a positive direction the collector current of transistor T1 decreases causing the collector to become more negative. This negative shift is coupled directly to the base of transistor T2 causing its collector current to decrease. This results in an amplified positive shift at the collector of T2.

At this point the shift is capacity coupled to the base of transistor T3 which is held at about 6v by the voltage divider network made up of a 2.7K and a 8.25K resistor between +12v and -12v. The positive shift applied to the base of T3 reduces its conduction causing a negative shift at its collector. Note that a positive shift on the base of T3 also causes a positive shift on its emitter. This shift is capacity coupled back to the first stage (T1) emitter where it produces degeneration. The 100 ohm potentiometer in the emitter circuit of T1 determines the amount of negative feedback and controls the gain of the amplifier.

The collector output signal of T3 passes through a delay line (not shown) before it reaches the base of transistor T4, the emitter follower output. The delay line makes it possible to add small increments of delay to the signal to compensate for manufacturing tolerances in the read head.

The emitter follower output stage (T4) feeds the amplified read signal to the external control. The emitter load for T4 is in the external control as indicated in Figure 11.1-1.

Transistor T5 functions as a gate for the preamplifier output. The base of transistor T5 is connected to the junction of a voltage divider. One end of this divider is connected to +12v. The other end of the divider may be either +6v or -6v (read gate). The emitter of T5 is connected directly to +6v. The collector connects directly to the base of T4. When the read gate is at a +6v level, the base of T5 is positive in reference to its emitter and, because it is a PNP transistor, it will be reverse biased (cut-off). In this condition T5 appears as a high resistance across the base circuit of T4 and has no effect on preamplifier operation.

When the read gate is at its down level (-6v) the base of T5 is negative in reference to its emitter (forward biased) and T5 conducts heavily. T5 now appears as a low resistance across the input to the emitter follower and prevents any change in level at this point. This, in turn, prevents any output from the emitter follower stage. The read gate is up (+6v) when the tape unit is selected and ready (Systems 01.02.1).

11.2.00 WRITE CIRCUITS

Writing bits on tape was covered previously. This section discusses, in detail, the write trigger and the head driver.

11.2.01 Write Trigger

The write trigger (Figure 11.2-1) is a voltage mode, self gated binary input trigger. Each time a sample pulse (write pulse) is applied to the binary input, the trigger changes its status (flips), providing it is first conditioned by an up level on the gate input.

To understand the circuit, consider transistor T1 conducting and transistor T2 cut-off. At this time the voltage at the collector of T1 is 0v. Because the collector of T1 is connected directly to the base of the emitter follower (T3), the voltage level at the emitter of T3 will also be 0v. At this time the voltage divider (R7 and R8) will have about +1.65 volts at its junction. This positive level on the base of T2 keeps it cut off.

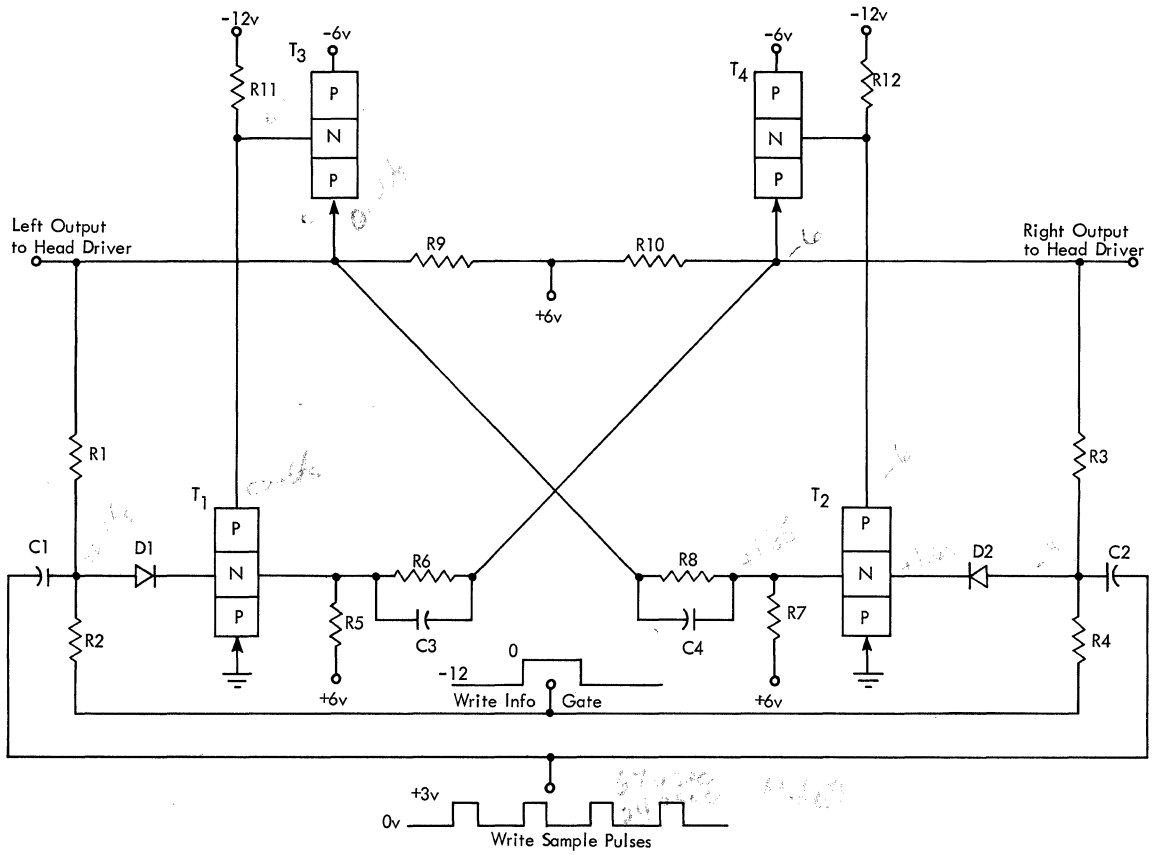


FIGURE 11.2-1. WRITE TRIGGER

Because T2 is cut off, its collector tends to go to -12v but will be clamped at -6v by the action of the emitter follower T4. The -6v on the base of T4 produces a -6v level on its emitter, causing the junction of the voltage divider (R5 and R6) to tend to go to -2.7v; however, transistor T1 being in conduction clamps the junction at 0v. In this status the left output is 0v; the right output is -6v.

Before attempting to flip the trigger with a write pulse, the self-gated binary input should be considered. Transistors T1 and T2 each have an input voltage divider consisting of R1, R2, and R3, R4, respectively. The junction of these dividers is connected to the base of T1 and T2 through diodes D1 and D2.

Assuming the output levels previously stated and an up level (0v) on the gate input, the junction of the left input divider R1, R2 will be at 0v. At the same time, the junction of the right divider will be at -3v level.

The write pulse is capacity coupled to both input dividers through capacitors C1 and C2. Note that when the write pulse occurs, a 3v positive shift will be applied to the junctions of both input dividers. Because diode D2 is reverse biased by about 4.65v (+1.65v cathode, -3v anode) the 3v pulse will have no effect on transistor T2. Diode D1, however, has no reverse bias at this time and the 3v positive shift is applied to the base of T1 cutting it off. As T1 cuts off, its collector voltage drops to -6v causing the emitter of T3 to become -6v. This action causes the junction of the voltage divider (R7 and R8) to head toward a -2.7v level; however, T2 will conduct, clamping the junction at 0v. With T2 conducting, T4 has 0v on its emitter. This action produces +1.65v at the junction of voltage divider R5 and R6, holding T1 cutoff.

The trigger has now changed status and the outputs will be: left output, -6v; right output, 0v. Note that diode D1 is reverse biased and when the next write pulse occurs, it passes through D2 flipping the trigger back to its original status (assuming gate is still up).

Write pulses occur at regular intervals during a write operation; however, we want only a particular write trigger to flip if there is information to be written.

When no information is on the write bus, the gate input (Figure 11.2-1) is at -12v for the associated trigger. This holds the junction of both input dividers negative enough to prevent the write pulses (+3v shift) from having any effect on either transistor T1 or T2.

11.2.02 Head Driver and Echo Pulse Amplifier

The purpose of this circuit (Figure 11.2-2) is to alternately pass current through one half of the write coil, then the other, under control of the write trigger. The circuit also produces an "echo" pulse each time current is switched in the write coil. The echo pulse is an indication to the external control that a character has been written.

Transistors T1 and T2 have their base connected to the junctions of voltage dividers. One end of these dividers is connected to a source of +6v. The other end is connected to the right and left outputs of a write trigger; when one input is at 0v level, the other is at -6v.

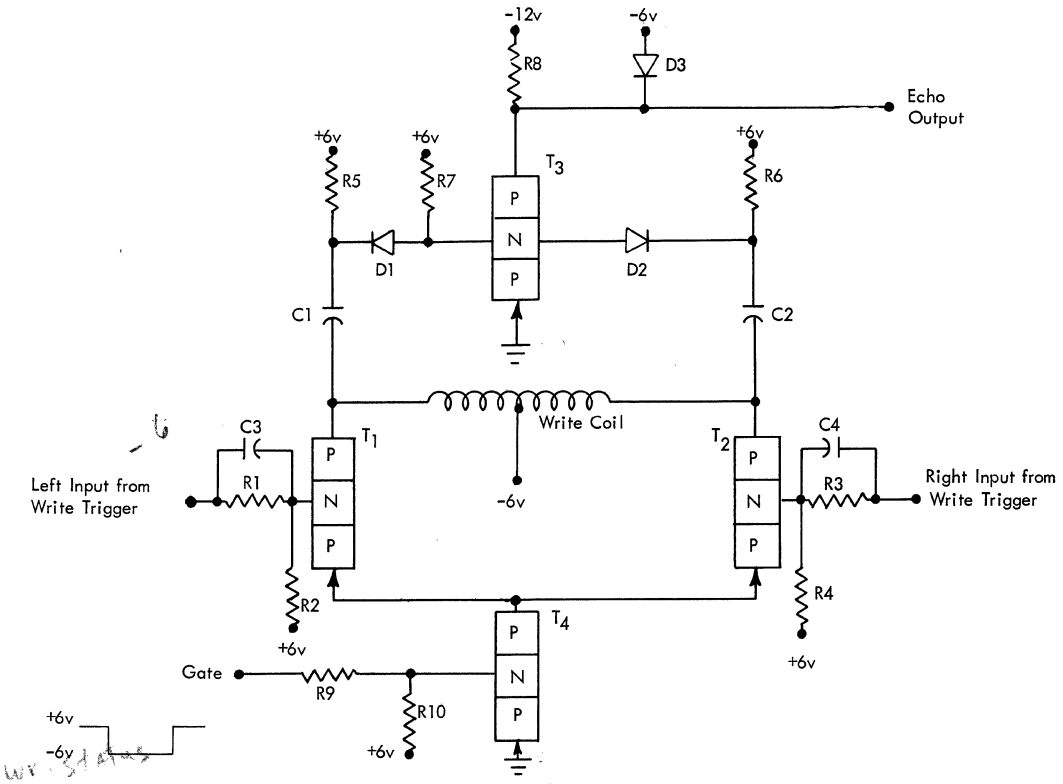


FIGURE 11.2-2. DRIVER AND ECHO PULSE AMPLIFIER

Note that a third input is connected to the base of transistor T4 through a voltage divider. This input is the write status gate and is -6v when the tape unit is in write status. When the gate is at -6v, the junction of the divider tends to go below ground but is clamped to ground because T4 goes into conduction. Transistor T4 acts as a switch, completing a current path for T1 or T2 only when the tape unit is in write status.

Consider the following conditions: The gate input is -6v, thus T4 is in full conduction and acts as a low resistance. The left input is -6v and the right input is 0v. This causes T1 to conduct while T2 is cut off. With T1 conducting, current flows from -6v through the left half of the write coil, through T1 and T4 to ground.

As long as current flows in the left half of the write coil, tape is magnetized to one level of saturation. Now consider the operation when the write trigger is flipped. The left input rises to 0v and the right input falls to -6v. This cuts off T1 and puts T2 into conduction. Current now flows from -6v through the right half of the write coil, through T2 and T4 to ground. With current flowing in the right half of the write coil, tape will be magnetized in the opposite direction.

The echo amplifier consists of transistor T3 and its two input circuits. Transistor T3 is normally reverse-biased so it is not in conduction. The collector tends to go to -12v but is clamped at -6v by diode D3. Transistor T3 has two input circuits: capacitor C1, diode D1, and capacitor C2, diode D2. Coupling capacitors C1 and C2 are coupled to the collectors of T1 and T2 respectively. When T1 conducts, its collector is at 0v; at this time T2 is cut off and its collector is at -6v. When current

is switched in the write coil, the voltage at the collector of T1 drops to -6v while the voltage at the collector of T2 rises to zero. This causes a positive shift of 6v on diode D2 but does not reach the base of T3 because of the polarity of the diode. At this same time, a 6v negative shift is applied to diode D1 and, because this is a negative shift, it reaches the base of transistor T3 causing it to conduct momentarily. While T3 is conducting, output rises to 0v, producing a 6v pulse at the output.

11.3.00 LOAD POINT AND END OF REEL PHOTO SENSING

Two identical photo-sensing circuits are employed in the 729 tape units: one for sensing the load point reflective spot, the other for sensing the end-of-reel reflective spot. These circuits use a photo cell which changes resistance when exposed to light. When dark, the photo cell acts as a high resistance. When illuminated by light from the reflective spot on tape the resistance of the cell drops.

11.3.01 Circuit Operation

In the quiescent state, the conditions of the circuit in Figure 11.3-1 are as follows: Transistor T1 is cut off, due to +6 volts on its base produced by resistor R4 and diode D1 connected between +12v and +6v. Transistor T2 is in partial conduction because the negative voltage on its base is determined solely by the voltage divider of R5, R6, and R7 connected between +12v and -12v. With transistor T2 conducting, the N line output is down (-1 volt). The P line output is up (-5v).

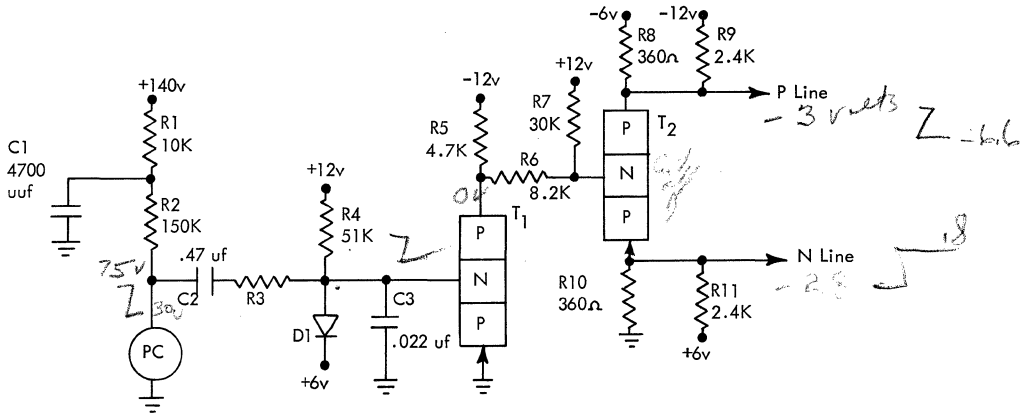


FIGURE 11.3-1. LOAD POINT AND END-OF-REEL PHOTO SENSING

The photo cell circuit of R1, R2 and the photo cell acts as a voltage divider with the photo cell having a high resistance (dark). This places the junction of R2 and the photo cell at a relatively high DC level. Coupling capacitor C2, therefore, has a considerable charge across it.

The circuit remains in this condition until light strikes the photo cell. The reduced resistance of the photo cell produces a negative shift of the voltage level at the junction of R2 and the cell. The coupling capacitor discharges through R4, producing a

negative shift in voltage at the base of transistor T1 and causing it to conduct momentarily. With T1 conducting, its collector voltage rised to about ground level (0v), producing a positive voltage shift at the base of transistor T2, cutting it off. While T2 is cut off the N line level is determined only by the divider current of R10 and R11 and will be +1v (up level). Also, the output of the P line will be -7v (down level). When transistor T1 again cuts off, transistor T2 goes back into conduction and the outputs return to their former levels.

11.4.00 END OF HIGH-SPEED AREA SENSING

Tape is in the high-speed rewind area whenever one-half inch or more of tape is present on the machine reel. This condition is sensed by a photo cell and lamp arrangement (Figure 11.4-1). The lamp, mounted in the upper right corner of the tape unit is focused between the sides of the machine reel so it strikes a photo cell mounted in the finger guard. When tape builds up on the machine reel the light beam is blocked and the cell is dark.

11.4.01 Circuit Operation

In Figure 11.4-1 consider first the conditions when the photo cell is illuminated (low speed area). The photo cell and resistors R1 and R2 form a voltage divider between +140v and -6v. When the cell is illuminated, its resistance is low, and voltage at the junction of R1 and R2 attempts to rise above +6v but is clamped at +6v by diode D1. At this time transistor T1 is cut off because its base is positive in respect to its emitter.

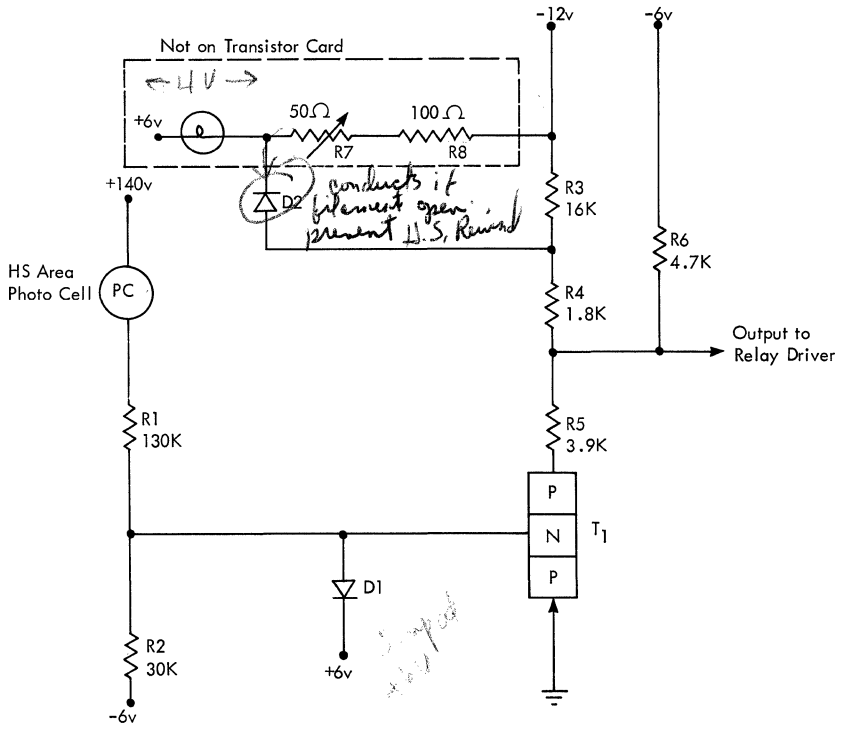


FIGURE 11.4-1. END OF HIGH-SPEED AREA SENSING

The output voltage level, with the transistor cut off is determined only by the current flow from -12v to -6v through R3, R4, and R6. The voltage level at the junction of R4 and R6 is about -7v (down level).

When light is blocked so the cell is dark, the increased resistance of the cell causes the voltage at the junction of R1 and R2 to fall toward a level below ground. As the junction of R1 and R2 approaches ground level, the transistor conducts and clamps the base voltage to ground. With the transistor conducting there is an additional current path from -12v and -6v to ground through R5 and the transistor. This raises the output level to -5v (up level).

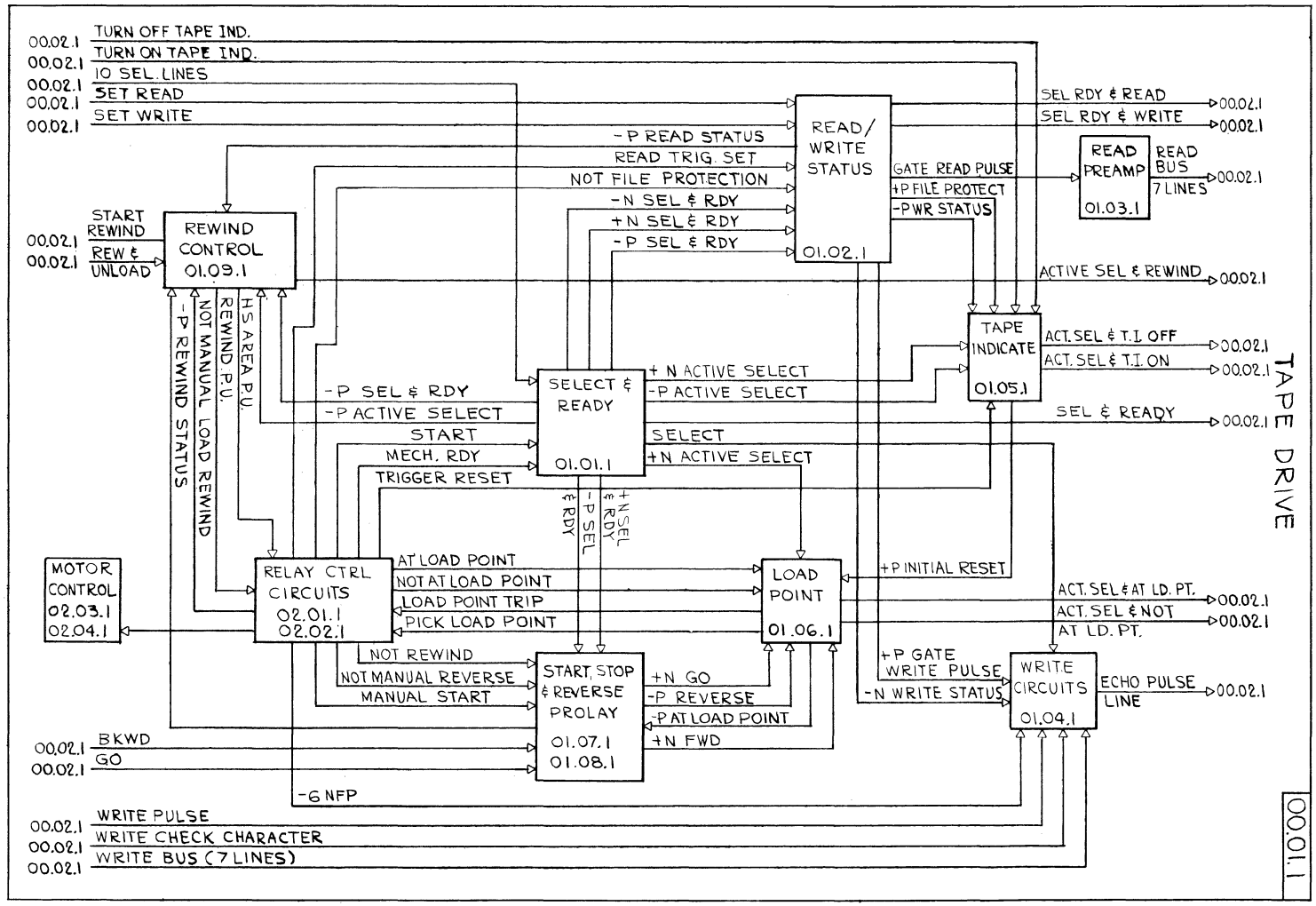
From Figure 11.4-1, note that the high-speed area lamp is connected between +6v and -12v through R7 and R8. Resistor R7 is variable and is used to adjust the intensity of the light beam.

A safety feature is incorporated to prevent high speed rewinding if the lamp burns out. The voltage at the junction of R7 and the lamp holds the cathode of diode D2 more positive than its anode when the lamp is operating properly. With reverse bias on diode D2, it presents a high resistance and has no effect on circuit operation. If the lamp filament opens, the junction of R7 and the lamp becomes more negative, causing diode D2 to conduct. This places R7 and R8, relatively low value resistors, in parallel with R3. With this condition, output voltage remains at a down level and high-speed rewinding does not occur.

12.0.00 SYSTEMS DIAGRAMS

12.1.00 IBM 729 II AND IV TAPE UNITS SYSTEMS DIAGRAMS

The following systems diagrams are for educational use only.


TAPE DRIVE
00.01.1
00.02.1 TURN OFF TAPE IND.
00.02.1 TURN ON TAPE IND.
00.02.1 IO SEL LINES
00.02.1 SET READ
00.02.1 SET WRITE
READ/ WRITE STATUS 01.02.1
-P READ STATUS
READ TRIG. SET
NOT FILE PROTECTION
-N SEL & RDY
+N SEL & RDY
-P SEL & RDY
GATE READ PULSE
+P FILE PROTECT
-PWR STATUS
SEL RDY & READ
SEL RDY & WRITE
READ PREAMP 01.03.1
READ BUS 7 LINES
START REWIND
00.02.1 REW & UNLOAD
REWIND CONTROL 01.09.1
ACTIVE SEL & REWIND
TAPE INDICATE 01.05.1
ACT. SEL & T.I. OFF
ACT. SEL & T.I. ON
SELECT & READY 01.01.1
+ N ACTIVE SELECT
-P ACTIVE SELECT
-P SEL & RDY
-P ACTIVE SELECT
START
MECH. RDY
TRIGGER RESET
SELECT
+N ACTIVE SELECT
SEL & READY
-P REWIND STATUS
NOT MANUAL LOAD REWIND
REWIND P.U.
HS AREA P.U.
-P SEL & RDY
+N SEL & RDY
MOTOR CONTROL 02.03.1 02.04.1
RELAY CTRL CIRCUITS 02.01.1 02.02.1
AT LOAD POINT
NOT AT LOAD POINT
LOAD POINT TRIP
PICK LOAD POINT
LOAD POINT 01.06.1
+P INITIAL RESET
ACT. SEL & AT LD. PT.
ACT. SEL & NOT AT LD. PT.
NOT REWIND
NOT MANUAL REVERSE
MANUAL START
START, STOP & REVERSE PROLAY 01.07.1 01.08.1
+N GO
-P REVERSE
-P AT LOAD POINT
+N FWD
+P GATE WRITE PULSE
-N WRITE STATUS
WRITE CIRCUITS 01.04.1
ECHO PULSE LINE
00.02.1 BKWD
00.02.1 GO
-6 NFP
00.02.1 WRITE PULSE
00.02.1 WRITE CHECK CHARACTER
00.02.1 WRITE BUS (7 LINES)

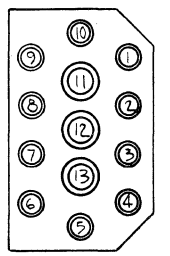
T/C CONNECTOR RECEPTACLE
(WIRING SIDE)

15	SHIELD	SET READ STATUS	SHIELD	SET WRITE STATUS	SHIELD	START REWIND	8 SHIELD	BKWD	SHIELD	GO	SHIELD	TURN OFF T.I.	SHIELD	1 TURN ON T.I.
30	SEL & NOT AT LD. PT.	SHIELD	SEL & AT LD. PT.	SHIELD	SEL & T.I. OFF	SHIELD	23 SEL & T.I. ON	SHIELD	SEL & RDY MOD IV	SHIELD	COUNT PULSE #2	SHIELD	COUNT PULSE #1	16 SHIELD
45	- SHIELD	SET HI-DENSITY	SHIELD	SET LO-DENSITY	SHIELD	REWIND & UNLOAD	38 SHIELD	SEL & REWIND	SHIELD	SEL RDY & WRITE	SHIELD	SEL & READ ONLY	SHIELD	31 SEL & RDY MOD II
60							53				SPARE	SHIELD	HI-DENSITY LO-DENSITY	46 SHIELD
75							68							61
85 SHIELD	READ BUS 2	SHIELD	READ BUS 1	81						80	SEL T.U. 1	SHIELD	SEL T.U. 0	76 SHIELD
95 READ BUS 8	SHIELD	READ BUS 4	SHIELD	91						90	SHIELD	SEL T.U. 3	SHIELD	86 SEL T.U. 2
105 SHIELD	READ BUS B	SHIELD	READ BUS A	101						100	SEL T.U. 5	SHIELD	SEL T.U. 4	96 SHIELD
115 SPARE	SHIELD	READ BUS C	SHIELD	111						110	SHIELD	SEL. T.U. 7	SHIELD	106 SEL T.U. 6
125 SHIELD	SPARE	SHIELD	SPARE	121						120	SEL T.U. 9	SHIELD	SEL T.U. 8	116 SHIELD
140 -6V							133	+6V						126
155							148							141
170 -12V							163	GND						156
185	WRITE BUS C	SHIELD	WRITE BUS B	SHIELD	WRITE BUS A	SHIELD	178 WRITE BUS 8	SHIELD	WRITE BUS 4	SHIELD	WRITE BUS 2	SHIELD	WRITE BUS 1	171 SHIELD
200			SHIELD	WRITE PULSE	SHIELD	WRITE CHECK CHAR	193 SHIELD	WRITE ECHO PULSE	SHIELD	SPARE	SHIELD	SPARE	187 SHIELD	SPARE

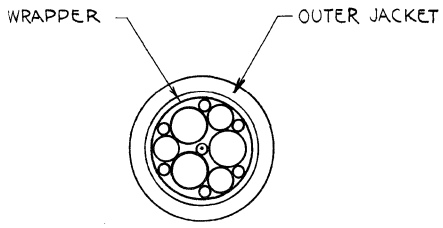
TAPE POWER CONNECTORS

POWER PLUG PIN ASSIGNMENTS				
TAPE UNIT		POWER CABLE		SYSTEMS PAGE
PIN NO.	VOLTAGE OR CONTROL	WIRE SIZE	TYPE	
1	AC OUTLET - 115 VOLTS	14	AC	02.04.1
2	AC OUTLET - 115 VOLTS	14	AC	02.04.1
3	BOND	14		02.04.1
4	SPARE	18		
5	MODEL II & IV RESET - 208 VOLTS	18	AC	02.04.1
6	SPARE	18		
7	SPARE	18		
8	SPARE	18		
9	SPARE	18		
10	MODEL II & IV RESET - 208 VOLTS	18	AC	02.04.1
11	UNREG AC Ø 1	10	AC	02.04.1
12	UNREG AC Ø 2	10	AC	02.04.1
13	UNREG AC Ø 3	10	AC	02.04.1

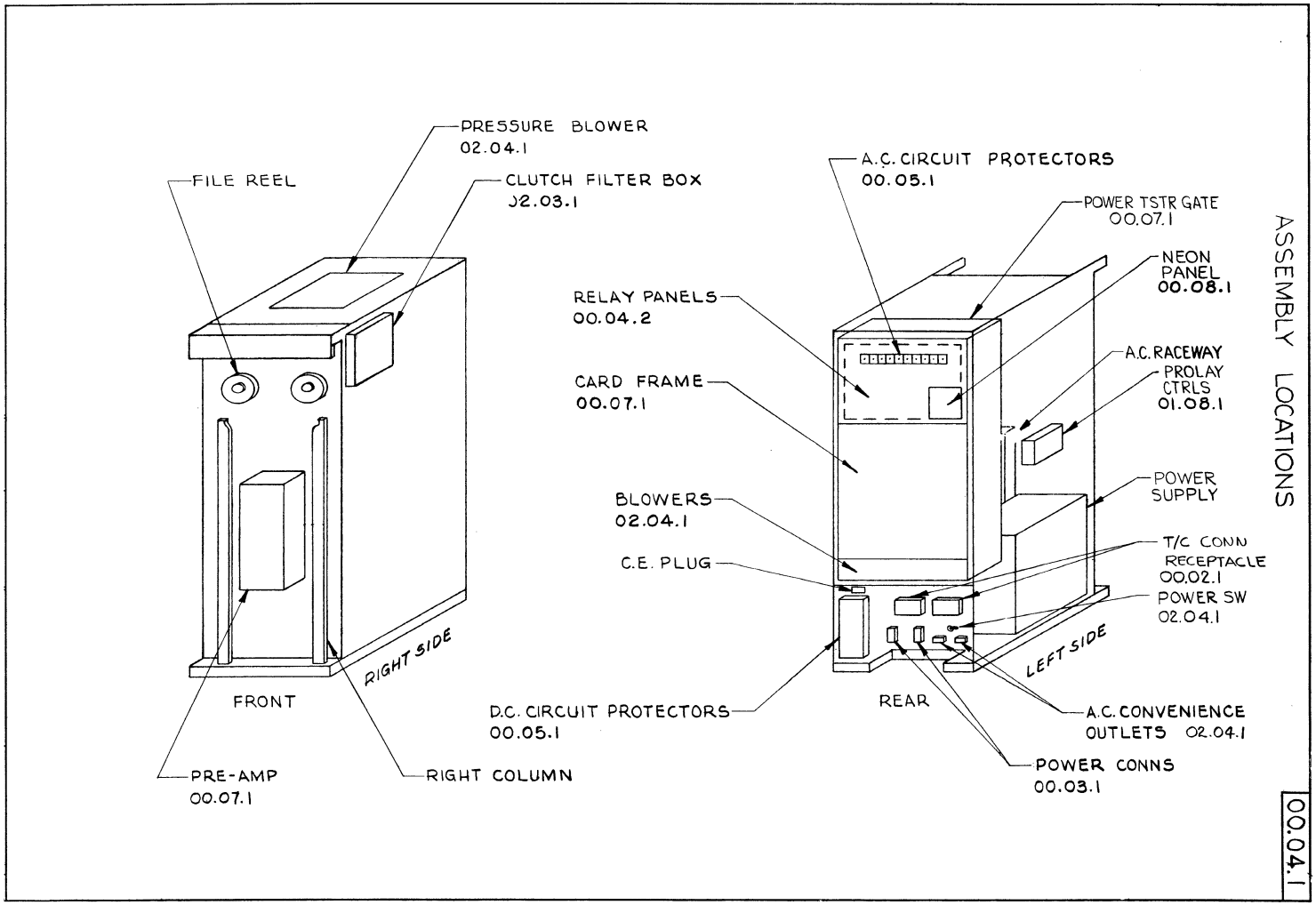
POWER PLUG PIN ASSIGNMENTS



PIN LAYOUT - POWER PLUG - MALE
WIRING SIDE



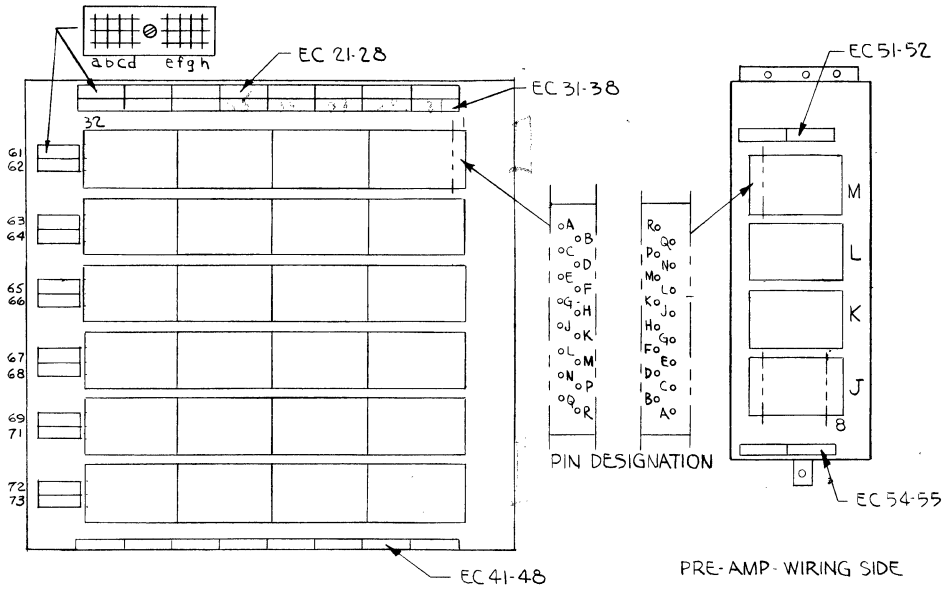
POWER CABLE
CROSS SECTION VIEW



ASSEMBLY LOCATIONS

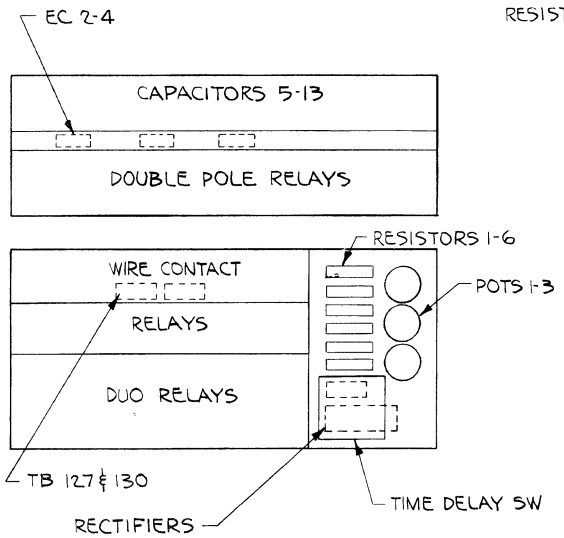
00.04.1

COMPONENT LOCATION

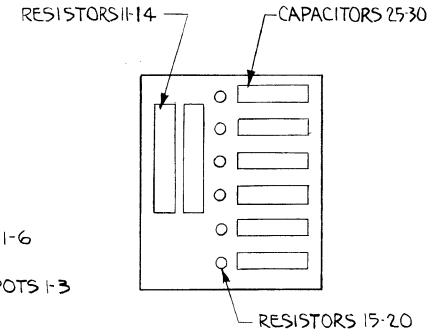


CARD FRAME- WIRING SIDE

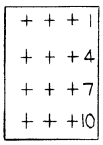
PRE-AMP- WIRING SIDE



RELAY FRAMES



CLUTCH FILTER BOX



POWER TSTR CONNECTOR

CIRCUIT PROTECTOR CHART

00.05.1

A.C. C.P.

C P#	VOLTAGE	CURRENT	FUNCTION	PART NO
1	208	7A	Ø 1 LINE	535296
2	↓	4A	Ø 1 POWER SUPPLY	535295
3		7A	Ø 2 LINE	535296
4		7A	Ø 3 LINE	535296
5		2A	Ø 3 GATE BLOWER	535294
6		2A	Ø3 VAC. PUMP & PRES. BLOWER	↑
7		2A	Ø 2 GATE BLOWER	
8		2A	Ø2 VAC. PUMP & PRES. BLOWER	
9	↓	2A	Ø 2 CAP & TAKE UP	↓
10	208	2A	Ø 3 CAP & TAKE UP	535294

D.C. C.P.

C.P. NO.	VOLTAGE	CURRENT	WIRE COLOR	PART NO.
1	-48	2A	GREEN	535294
2	-12	1A	VIOLET	535291
3	-6	2A	BROWN	535293
4	+6	2A	ORANGE	535293
5	+12	1A	GRAY	535291
6	-7.5	20A	BLUE	535297
7	+62	0.5A	WHITE	535290
8	+140F	0.5A	PINK	535290
9	+140	1A	RED	535292

LOCATION CHARTS

WIRE CONTACT RELAYS

RELAY NO.	SIZE	TYPE	PART NO.	COILS PU	COILS LT	POINTS 1	2	3	4	5	6	NAME	NEON NO.
101	6	S	196197	4D		1A	3B	1C	4D	3A		LOAD REW-2	3
102	6	S	196197	3D		2D	3A	2D	1A	3A		UNLOAD-2	39
104	6	S	196197	3B		1C	3B			2A	2D	REW STATUS-1	2
106	6	S	196197	3B			3B	2B	4A	2A		START	
107	4	L	186685	4B	3B	2A	1B	4C	1D			UNLOAD-1	40
109	4	L	186685	2D	1D	1C		2A	4B			UNLOAD STOP-1	43
110	4	S	196207	4B		4A	4C	4C	4A			REMOVE INITIAL RESET	
111	4	S	196207	4C		4D	1D	3A				REWIND P.U.	5
112	4	S	196207	2B		2A		2A	2A			NOT FILE PROTECT-2	
113	4	S	196207	2D		2F	2D	4A				H.S. REW STATUS	25
114	6	S	196197	2D			3E	2D				H.S. REW INTLK	24
116	4	L	186685	4C	4C	1C	4D	3B	3C			LOAD POINT	15
117	4	S	196207	3D		3B	4D	1D	2A			CAPSTANS OUT	16
119	4	S	196207	1D		3C	4D					MAN. GO	20
120	4	S	196207	1B		4B	4D	4C	2C			CLUTCH STATUS-2	36
121	4	S	196207	4C		3A	1B	2D				H.S. REW AREA	26
122	4	S	196207	3D					1C			UNLOAD-3	38
123	4	L	186685	4C	1D	3C	1C	2A				REW & UNLOAD	29
124	4	S	196207	4D		1A	3A					CE. PLUG	27

DUO RELAYS

RELAY NO.	PART NO.	COIL P.U.	POINTS AU	AL	BU	BL	NAME	NEON NO.
1	124843	1B	2A	3B	2E	2F	RUN	
2	↑	1B	3C	2E	2F		CLUTCH STATUS-1	37
3		4D		3B	3C	1B	LOAD REW-1	4
4		3B	1B	3D	4D	3A	H.S. REW END	1
5		3D	1A	1D	2C	2E	TAPE OUT LT. COL.	44
6		3D	1A	1C	2C	2F	TAPE OUT RT. COL.	44
7		4C		1B	4C	4C	PHOTO LAMP	13
8		1B	1G	1D	2C		TIME DELAY MOTOR	12
9	↓	3B		2E			REW STATUS-2	
NFP	124843	2B		2B		2A	NOT FILE PROTECT-1	

DOUBLE POLE RELAYS

RELAY NO.	PART NO.	COIL P.U.	POINTS A	B	NAME
DP1	223642	1B		1G	PHASE 1
DP2	↑	1B	1H	1H	PHASE 2 & 3
DP3		3D	2H	2H	CAPSTAN MOTORS
DP4		1D	1H	1G	VACUUM MOTOR
DP5		2D	2G	2G	REWIND MOTOR
DP6		3D	2H	2H	TAPE TAKE-UP START
DP7	↓	3B	2H	2H	TAKE-UP REVERSE
DP8	223642	2D	2H	2H	HEAD TAKE-UP MTR

CONTACTOR

NO.	PART NO.	LOC.	NAME
K1	369232	02.04.1	POWER ON

COUNTERS

NO.	PART NO.	LOC.
CTR #1 & CTR #2	535301	01.10.1

LOCATION CHARTS

KEYS & SWITCHES

NAME	LOCATION	NEON NO.
CAPSTAN IN SWITCH - LEFT	02.02.1(3C)	47
CAPSTAN IN SWITCH - RIGHT	02.02.1(3C)	47
CAPSTAN OUT SWITCH - LEFT	02.02.1(3D)	
CAPSTAN OUT SWITCH - RIGHT	02.02.1(3C)	
DOOR CLOSED INTERLOCK	02.01.1(2A)	
HEAD DOWN SWITCH	02.01.1(1A)	18
HEAD UP SWITCH	02.02.1(2C)	46
H.S. REW THERMAL CUT OUT	02.01.1(3A)	
LOAD REWIND P.B.	02.01.1(4A)	
REEL RELEASE P.B.	02.03.1(2F)	
RESET P.B.	02.01.1(3A)	
START P.B.	02.01.1(3A)	
TAPE IN COL SW - LEFT	02.02.1(3C)	9
TAPE IN COL SW - RIGHT	02.02.1(3C)	8
TIME DELAY SW	02.02.1(2D)	19
UNLOAD P.B.	02.01.1(4A)	
VACUUM COL SW - LEFT	02.03.1	
VACUUM COL SW - RIGHT	02.03.1	
VACUUM OFF BELLOWS SW	02.01.1(1B)	11
SELECTOR SW	02.01.1(4A)	
CHANGE DENSITY P.B.	02.02.1(1C)	

LIGHTS & LAMPS

NAME	LOCATION
FILE PROTECT LIGHT	02.01.1(2B)
FUSE LIGHT	02.01.1(2B)
H.S. AREA LAMP	01.09.1
LOAD POINT LAMP	02.02.1(4D)
READY LIGHT	02.01.1(2B)
SELECT LIGHT	01.01.1
TAPE BREAK LAMP	02.02.1(4D)
TAPE INDICATE LAMP	02.02.1(4D)
TAPE INDICATE ON LIGHT	01.05.1
ADDRESS LIGHT	02.01.1(2A)
POWER OFF LIGHT	02.04.1(1G)
POWER ON LIGHT	02.04.1(1G)
HI & LO DENSITY LIGHTS	01.02.2

DIODES

NO.	PART NO.	LOC.
1	315902	3B
2	"	3B
3	"	4A
4	"	1B
5	"	1C
6	"	3B
7	"	3B
8	"	3B
9	"	4B
10	315902	2C

POTENTIOMETERS

NO.	PART NO.	LOC.	NAME
1	528154	01.09.1	H.S. AREA LAMP
2	333198	02.02.1	PHOTO LAMP
3	535673	02.03.1	STOP CLUTCH
4	528459	01.08.1	PROLAY - NEUTRAL
5	528481	01.08.1	PROLAY - DRIVE

PHOTO CELLS

NAME	LOC.
H.S. AREA	01.09.1
LOAD POINT	01.06.1
TAPE BREAK	01.06.1
TAPE IND.	01.05.1

LOCATION CHART

00.07.1

CARD FRAME

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A			02.2	09.1	02.2	05.1	09.1	05.1	05.1	05.1	05.1	02.1	04.1	05.1	05.1	01.1	01.1	02.1	02.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	
B			02.2		09.1	02.2	09.1	05.1	05.1	05.1	05.1	02.2	05.1	05.1	07.1	01.1	02.1	02.1	02.1	04.1	04.1	04.1	04.1	04.1		04.1	04.1	04.1	04.1	04.1	04.1	
C	10.1	10.1	10.1	10.1	10.1	10.1	02.2	02.2	02.2	06.1	06.1	06.1	06.1	06.1	01.1	01.1	02.1		02.1	02.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	
D	10.1	10.1	10.1	10.1						06.1	06.1	06.1	06.1		07.1				02.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	
E							09.1					07.1 09.1	07.1		07.1	08.1	08.1	08.1	08.1	04.1		04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	
F							02.1	06.1	07.1	07.1	07.1	07.1 05.1	07.1	08.1	08.1	08.1	08.1	08.1	08.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	04.1	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A		371211	371209	371200	371428	371200	371215	371228	371218	371200	371442	371209	371206	371209	371200	371206	371209	371204	371200	371442	371442	371442	371038	371033	371038	371038	371033	371038	371038	371038		
B		371043	371206		371213	371213	371215	371431	371435	371438	371228	371435		371427	371428	371428	371427	371428	371204	371442	371442	371442	371439		371439	371439	371439		371439	371439	371439		
C	371202	371213	371200	371435	371204	371040	371205	371420	371420		371204	371228	371442	371200	371435	371209	371200		371228	371442	371442	371442	371439	371031	371439	371439	371439	371439	371439	371439		
D	371202	371213	371200	371040						371438		371213		371204	371213				371213	371238	371202	371417	371202	371417	371417	311202	371417	371417	371202	371417	371417		
E							371209					371200	371204		371218	371445	371209	371209	371204	371200		371032	371034	371433	371034	371034	371034	371034					
F							371209	371206	371206	371200	371209	371213	371213	371433	371445	371204	371434	371204	371434	371211	371030	371206	371201	371031	371201	371201	371201	371201	371201	371201	371201		

PRE-AMP

	1	2	3	4	5	6	7	8	
J									J
K	03.1							03.1	K
L	371432							371432	L
M	03.1							03.1	M
	371437							371437	
	03.1							03.1	
	371436							371436	
	1	2	3	4	5	6	7	8	

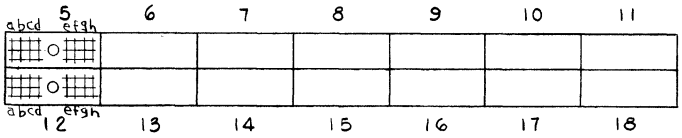
POWER TRANSISTORS

1 528405 08.1	2 528405 08.1	3 528405 08.1	4 528405 08.1
5 528405 08.1	6 528405 08.1	7 528405 08.1	8 528405 08.1
9 528455 01.1, 06.1, 09.1	10 528455 05.1, 06.1, 09.1	11 528455 09.1, 10.1	12 528455 02.2

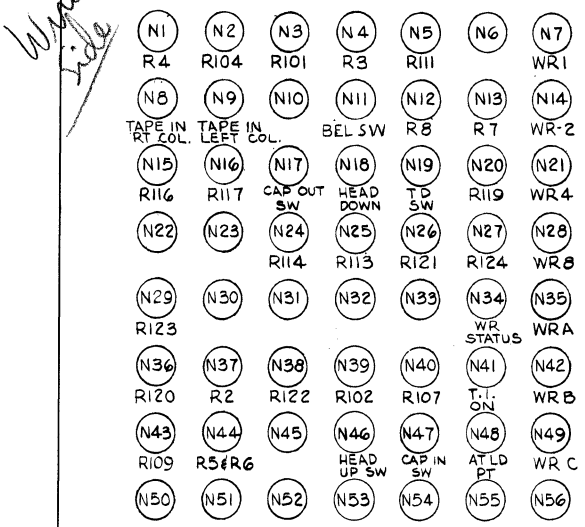
NOTE: ALL INDEX NUMBERS PREFIXED BY 01

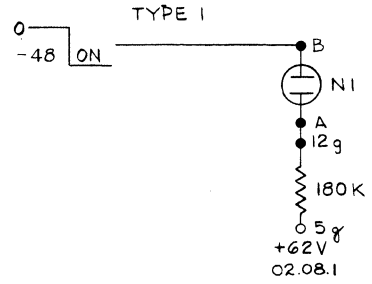
NEON PANEL

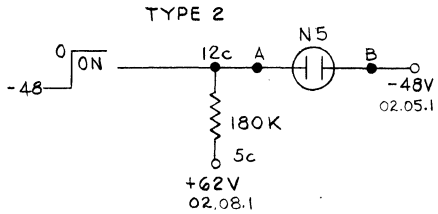
00.08.1



Wiring Side

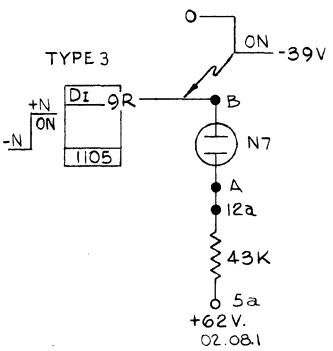






NO.	E.C.	TYPE CKT.	SYSTEM LOC.
1	12g	1	02.01.1 (3B)
2	12f	1	02.01.1 (3B)
3	12e	2	02.01.1 (1A)
4	12d	1	02.02.1(3C)
5	12c	2	02.02.1(4D)
6	12b		
7	12a	3	01.04.1
8	13f	1	02.02.1 (3D)
9	13e	1	02.02.1 (3D)
10	13d		
11	13c	1	02.01.1 (1B)
12	13b	1	02.01.1 (1B)
13	13a	2	02.02.1 (4C)
14	12h	3	01.04.1
15	14e	1	02.02.1 (3C)
16	14d	1	02.02.1 (4C)
17	14c	1	02.02.1 (3D)
18	14b	1	02.01.1 (1A)
19	14a	1	02.02.1 (3D)
20	13h	1	02.02.1 (3C)
21	13g	3	01.04.1
22	15d		
23	15c		
24	15b	1	02.02.1 (2D)
25	15a	2	02.02.1 (2D)
26	14h	1	02.01.1 (3A)
27	14g	1	02.01.1 (1A)
28	14f	3	01.04.1

NO	E.C.	TYPE CKT	SYSTEM LOC
29	16c	3	
30	16b		
31	16a		
32	15h		
33	15g		
34	15f	3	01.02.1
35	15e	3	01.04.1
36	17b	1	02.01.1 (1B)
37	17a	2	02.02.1 (3D)
38	16h	1	02.02.1 (3D)
39	16g	1	02.01.1 (3A)
40	16f	1	02.02.1 (4C)
41	16e	3	01.05.1
42	16d	3	01.04.1
43	18a	1	02.02.1 (1C)
44	17h	1	02.02.1 (2C)
45	17g		
46	17f	1	02.02.1 (2D)
47	17e	1	02.02.1 (2C)
48	17d	3	01.06.1
49	17c	3	01.04.1
50	18h		
51	18g		
52	18f		
53	18e		
54	18d		
55	18c		
56	18b		



WRITE AMPLIFIER (SEE .01.04.1)

TRACK NO.	CARD LOCATIONS												INPUT WR BUS				OUTPUTS RED		WHITE		BLK (CTR TAP)		SHIELD	IND	NEON	
	1202		1031		1439	1439	1033		1038	1034	1417	1442	SIG. T/C	E.C.	SHIELD T/C	E.C.	E.C.	PLUG	E.C.	PLUG	E.C.	PLUG			NO.	E.C.
1	D21	B	C24	A	C23	B23	A24	A	A23	E23	D22	A20					22g	B	22h	C	32g	R	32h	23h	N7	12a
	F23	A	F24	A									172	42e	171	42f										
2	D21	G	C24	B	C25	B25	A24	B	A25	E25	D24	A21					22e	S	22f	D	32e	T	32f	23g	N14	12h
	F25	A	F24	B									174	42c	173	42d										
4	D23	B	C24	C	C26	B26	A24	C	A26	E26	D25	A22					22c	E	22d	U	32c	F	32d	23f	N21	13g
	F26	A	F24	C									176	42a	175	42b										
8	D26	B	C28	A	C27	B27	A28	A	A27	E27	D27	B20					22a	H	22b	V	32a	J	32b	23e	N28	14f
	F27	A	F29	A									178	41g	177	41h										
A	D26	G	C28	B	C29	B29	A28	B	A29	E28	D28	B21					21g	K	21h	W	31g	L	31h	23d	N35	15e
	F28	A	F29	B									180	41e	179	41f										
B	F29	B	C28	C	C30	B30	A28	C	A30	E30	D30	B22					21e	Y	21f	X	31e	M	31f	23c	N42	16d
	F30	A	F29	C									182	41c	181	41d										
C	D29	G	C28	D	C31	B31	A28	D	A31	E31	D31	C22					21c	A	21d	P	31c	N	31d	23b	N49	17c
	F31	A	F29	D									184	41a	183	41b										

READ PRE-AMP (SEE .01.03.1)

TRACK NO.	CARD LOCATION			INPUTS RED (GND)		YELLOW		OUTPUT E.C.	SIG. T/C	SHIELD T/C
	1436	1437	1432	E.C.	PLUG	PLUG	E.C			
1	M01	L01	K01	51b	F	H	51a	55a	82	83
2	M02	L02	K02	51d	E	P	51c	55b	84	85
4	M03	L03	K03	51f	D	N	51e	55c	93	92
8	M04	L04	K04	51h	C	B	51g	55d	95	94
A	M05	L05	K05	52b	M	A	52a	55e	102	103
B	M06	L06	K06	52d	R	L	52c	55f	104	105
C	M07	L07	K07	52f	J	K	52e	55g	113	112

Rotary on panel Switches

Select light will come on regardless of ready condition

.01.01.1

SELECT READY

+P SEL T U COM
SEL T U 0-9
.00.02.1
SHIELD

PWR TSTRS

SELECT

-48V
.02.05.1
CE 14

+N SELECT
.01.04.1

+W START
.02.01.1

+N ACT SELECT
.01.02.2
.01.09.1
.01.05.1
.01.06.1

-P ACT SELECT
.01.05.1
.01.09.1
.01.02.2

+W MECH RDY
.02.01.1

+N SEL+RDY
.01.02.1
.01.07.1

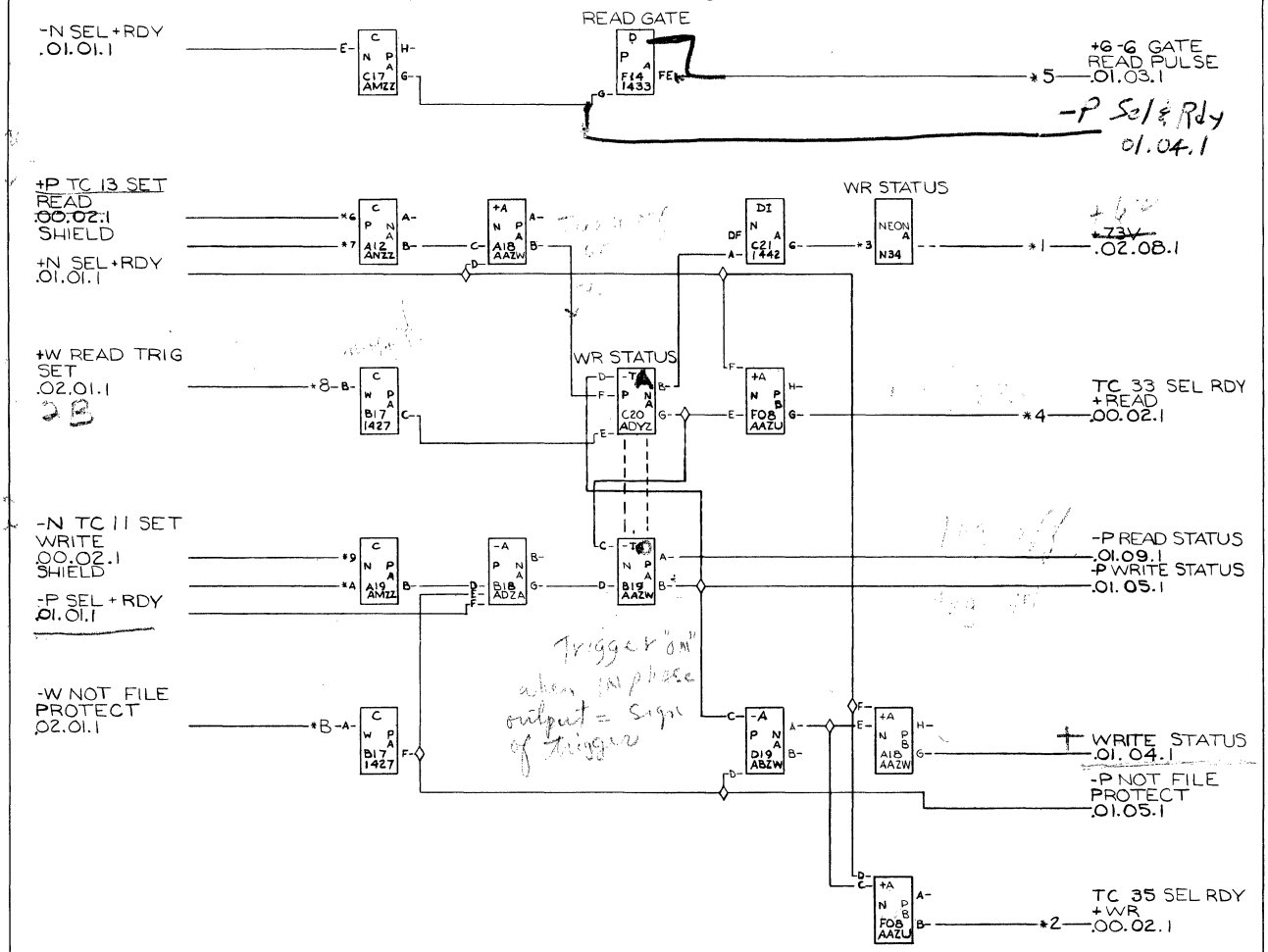
-N SEL+RDY
.01.02.1

-P SEL + RDY
.01.02.1
.01.07.1
.01.09.1

SEL+RDY TC 21
.00.02.1

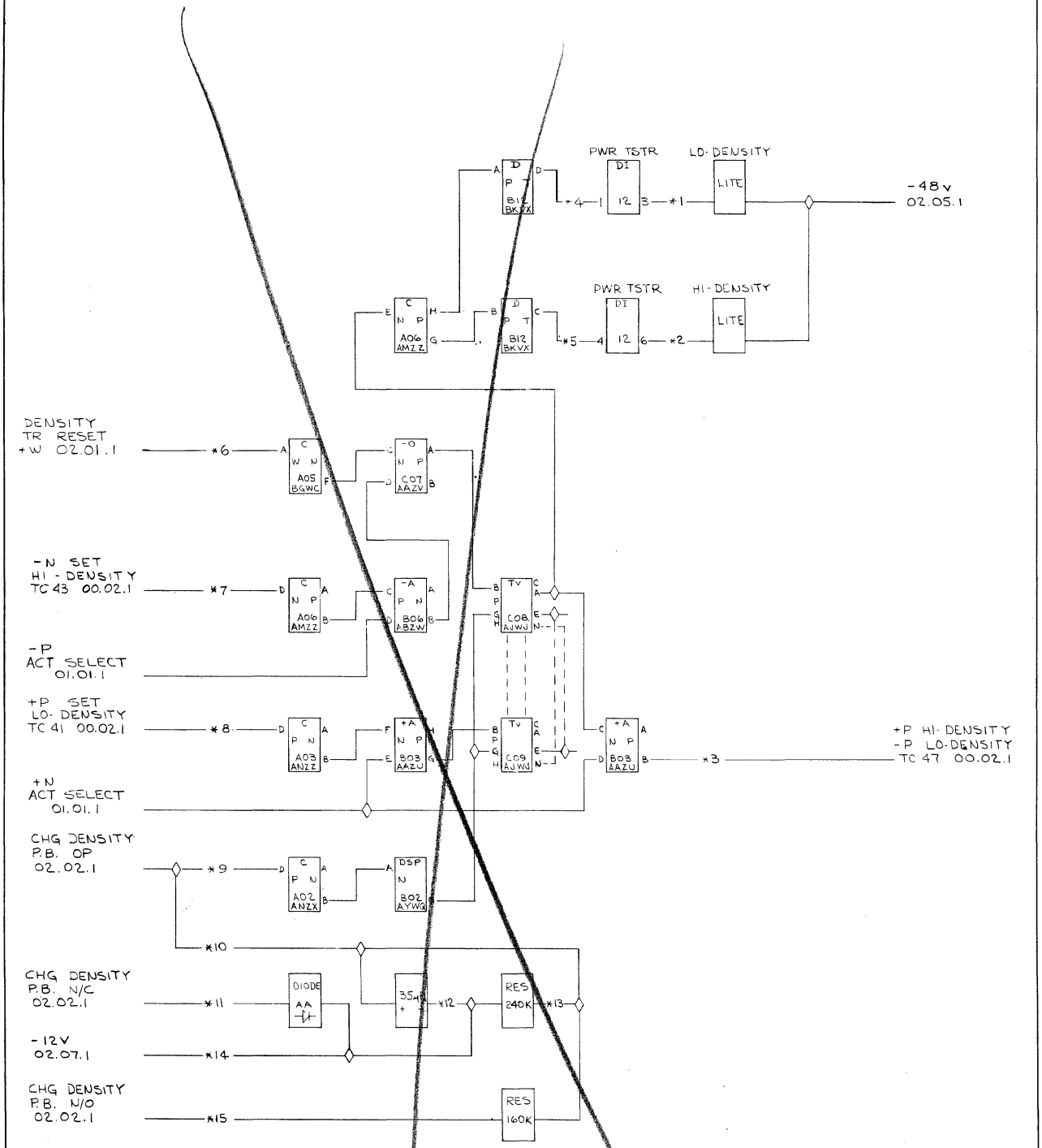
*1-TP0-48-III S *2-III S *3-34G. *4-TP0 6-25C IXW-III M-7 *5-34E. *6-34F *7-IXJ 24C *8-IXN 24D

READ WRITE STATUS



*1-43K. *2-46C. *3-TP 36 0 *4-34C. *5-45E. *6-36A. -D- *7-36B -K- *8-IXE 24A
*9-34A. -D- *A-34B -J- *B-IXC 24B

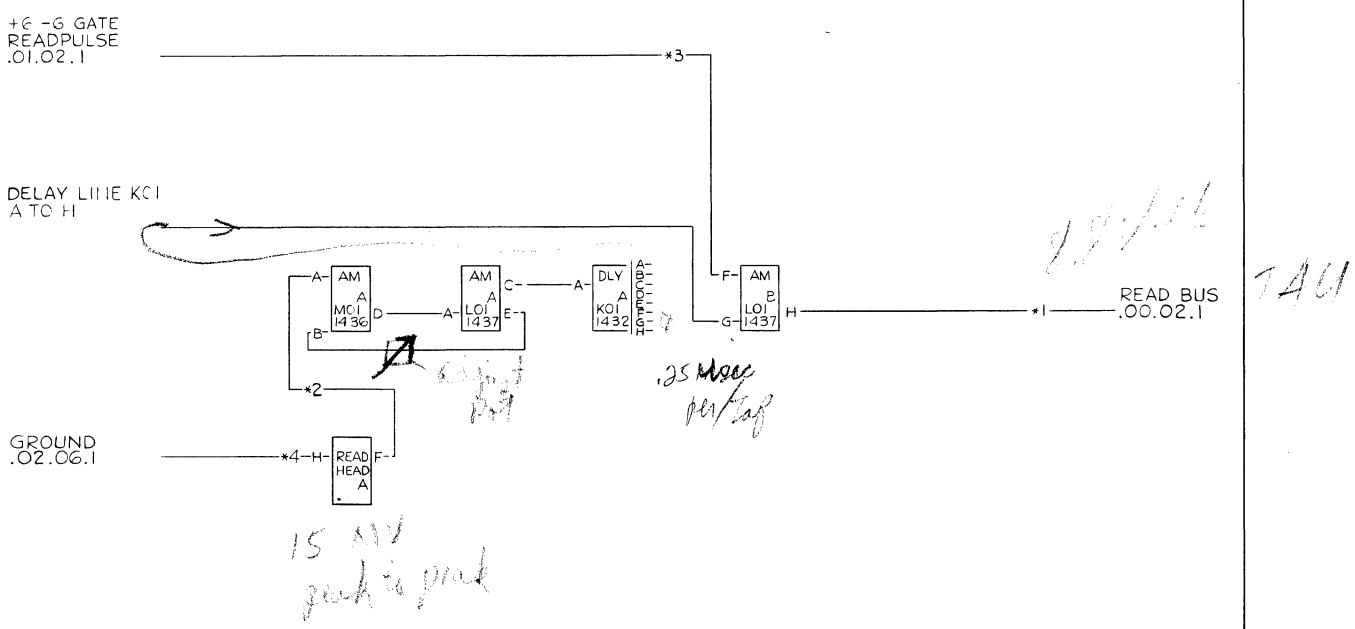
DUAL DENSITY



*1- TP 0-48 ⅨT *2- TP 0-48 ⅨW *3- 36E *4- TP 0-6 26C ⅨT ⅨR *5- TP 0-6 26E ⅨU ⅨV
*6- ⅨS 33G *7- 26F *8- 33B *9- ⅨY 33H *10- ⅨP 37G *11- ⅨN 38A *12- 38C *13- 37H
*14- 28H 38D *15- ⅨT 38B

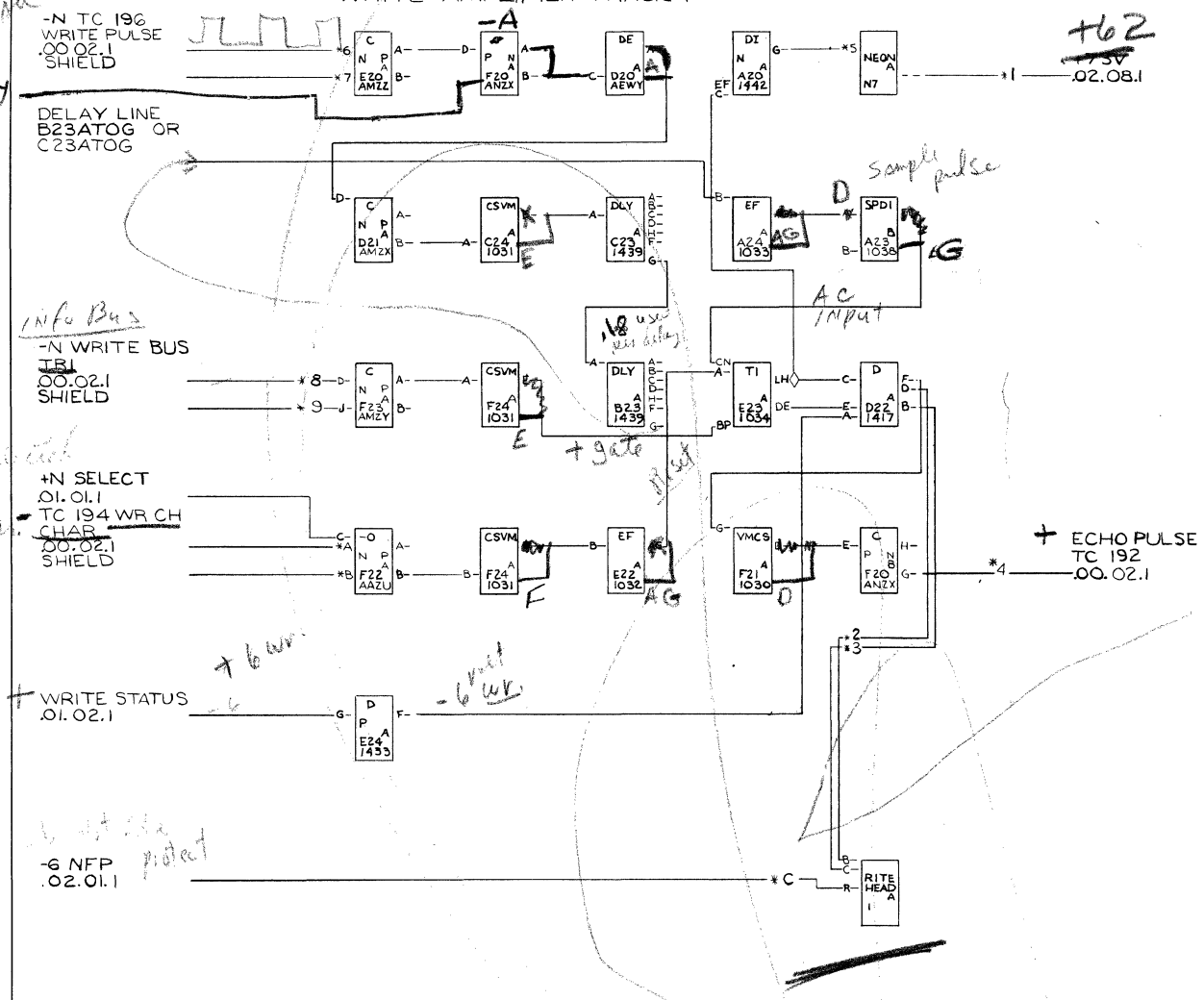
.01.03.1

READ PREAMP TRACK 1



*1-55A *2-51A *3-54H *4-51B

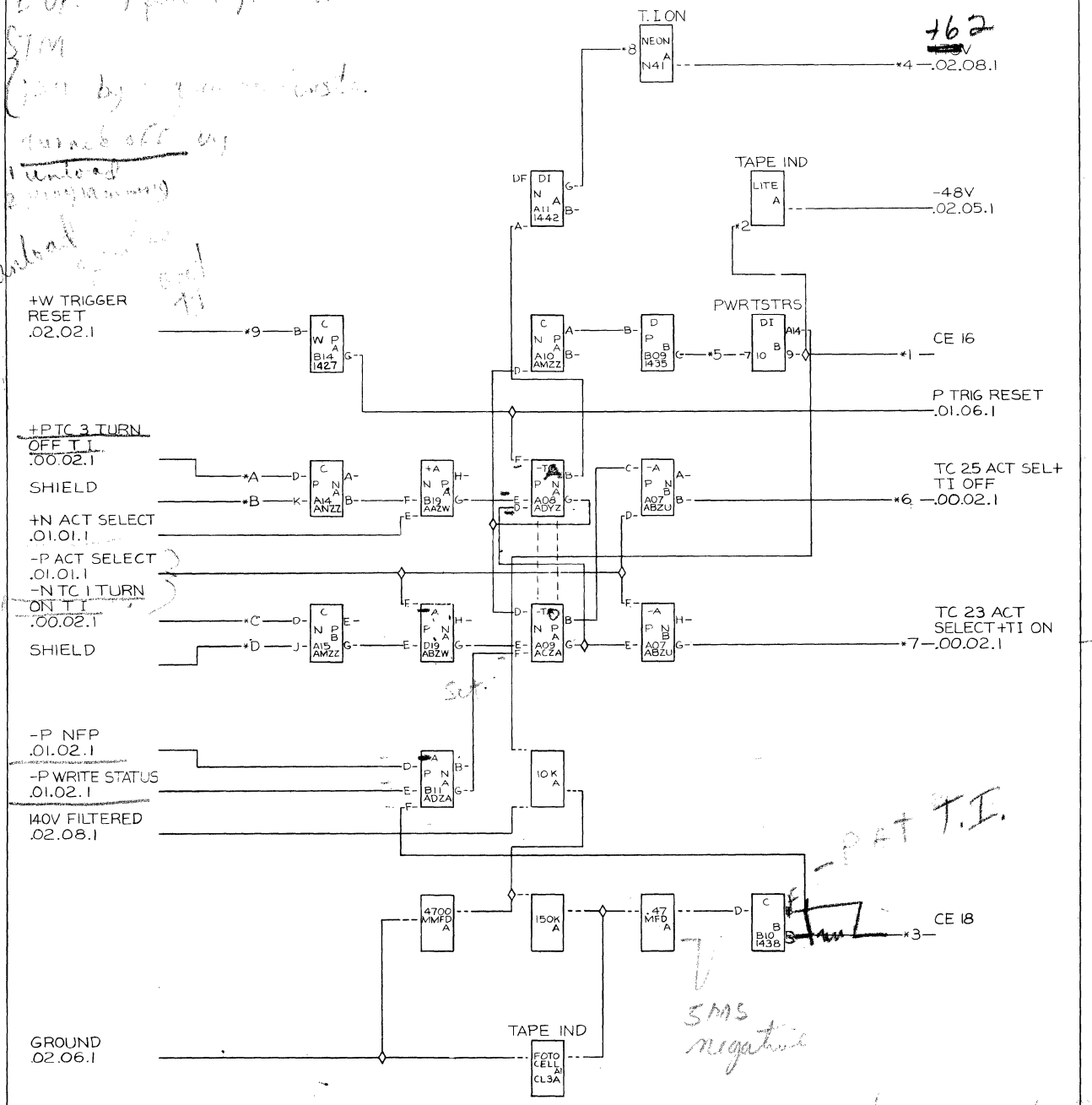
WRITE AMPLIFIER TRACK 1



current is always flowing when in WR STATUS and -6 NFP.

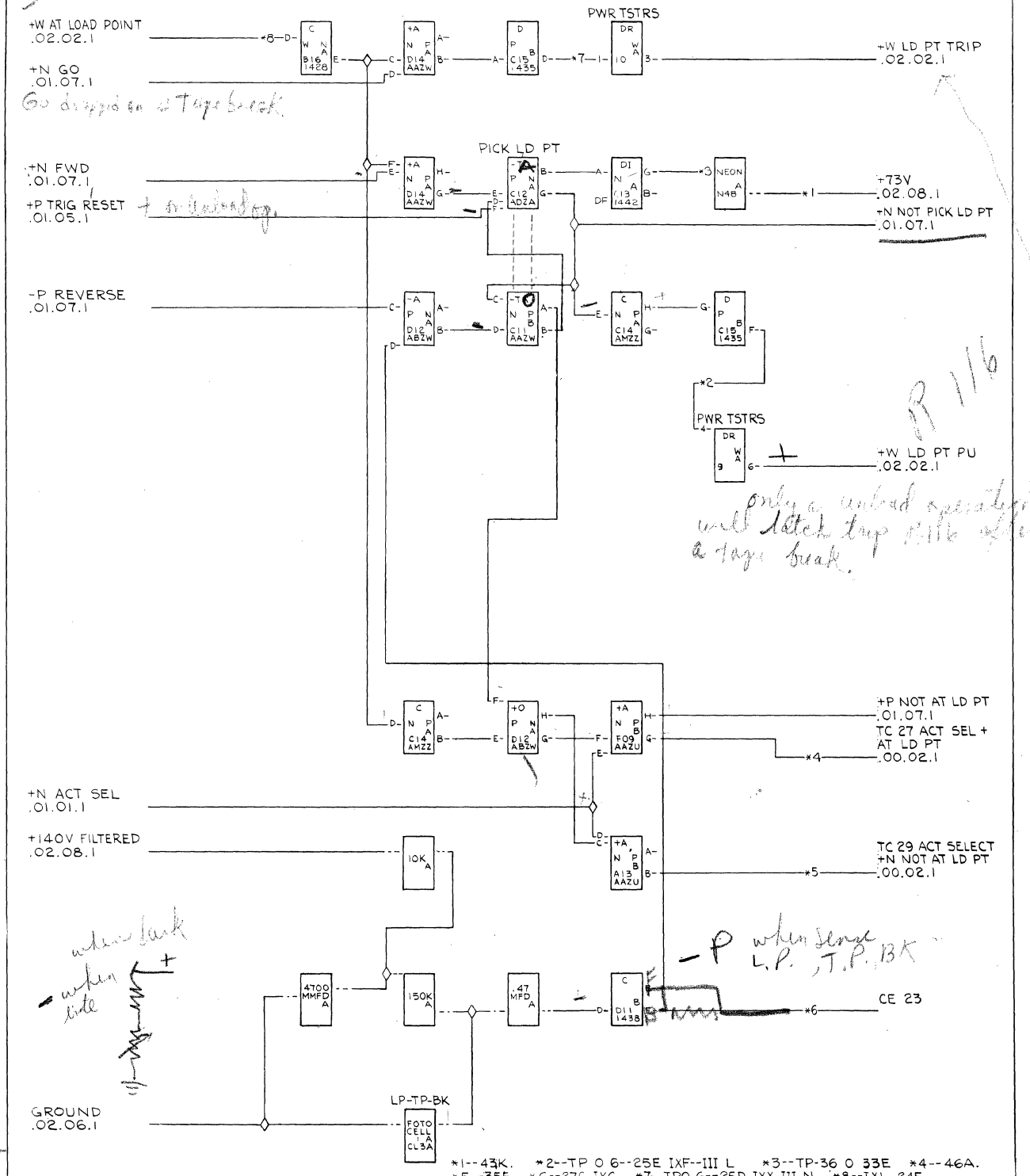
*1-43K *2-22G *3-22H. *4-43E. *5-TP-36 O 23H *6-43A.-D- *7-43B--J- *8-42E. 9-42F.
*A-43C.--D- *B-43D.--J- *C-32G.

TAPE INDICATE

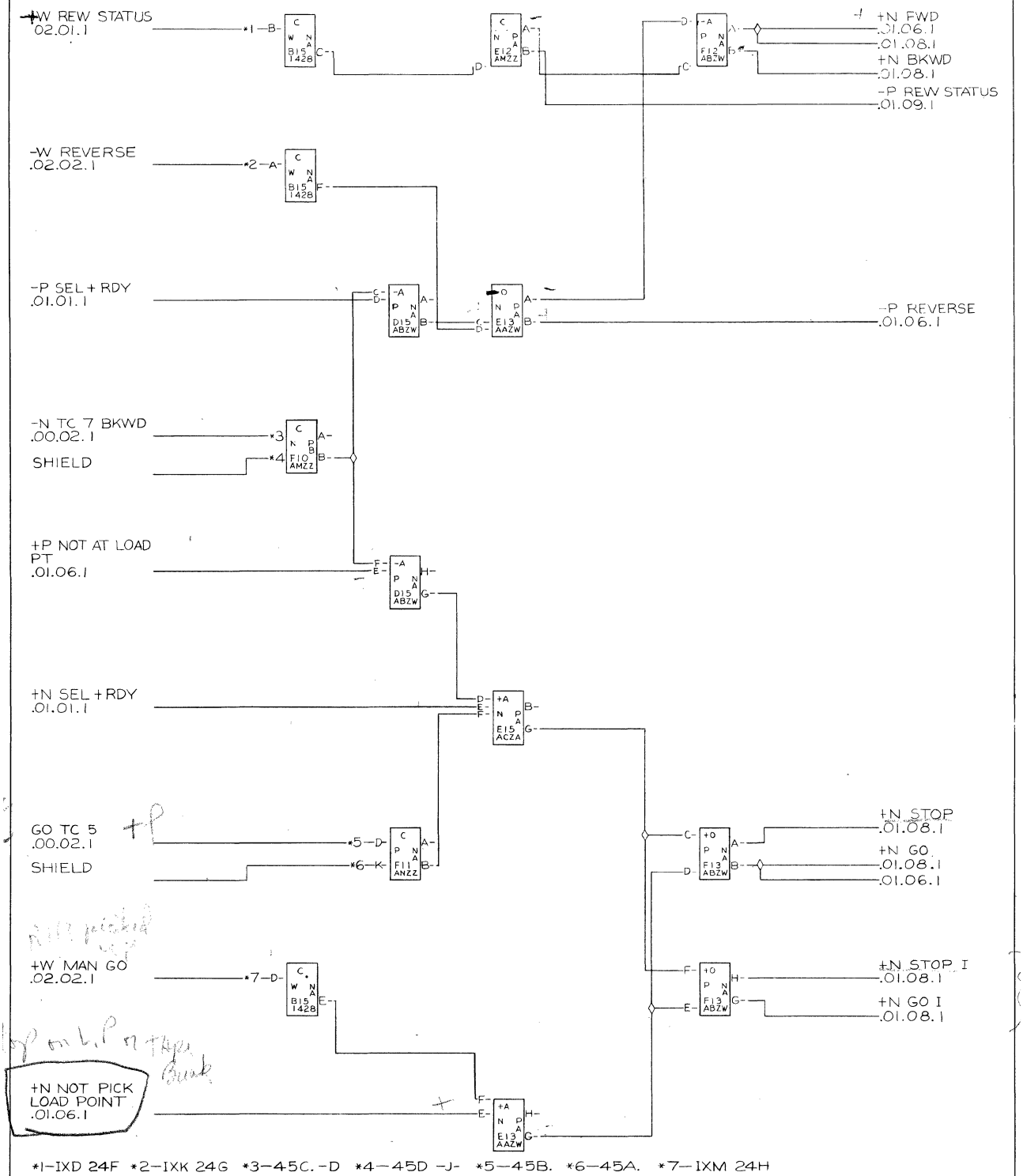


*1—TP0-48—III T *2—IP0-48—III 16 *3—27A JX-A *4—43K. *5—TP0 6—25E IXE—III R *6—36C *7—37A.
*8—TP-36 0 *9—IXH 25A *A—35C. *B—35D. *C—35A.

LOAD POINT


+W AT LOAD POINT .02.02.1
+N GO .01.07.1
+N FWD .01.07.1
+P TRIG RESET .01.05.1
-P REVERSE .01.07.1
+N ACT SEL .01.01.1
+140V FILTERED .02.08.1
GROUND .02.06.1
PWR TSTRS
+W LD PT TRIP .02.02.1
PICK LD PT
+73V .02.08.1
+N NOT PICK LD PT .01.07.1
PWR TSTRS
+W LD PT PU .02.02.1
+P NOT AT LD PT .01.07.1
TC 27 ACT SEL + AT LD PT .00.02.1
TC 29 ACT SELECT +N NOT AT LD PT .00.02.1
CE 23
LP-TP-BK
10K A
4700 MMFD A
150K A
.47 MFD A
*1--43K. *2--TP O 6--25E IXF--III L *3--TP-36 O 33E *4--46A.
*5--35E. *6--27C IXC *7--TPO 6--25D IXX III N *8--IXL 24E

START STOP AND REVERSE CONTROL

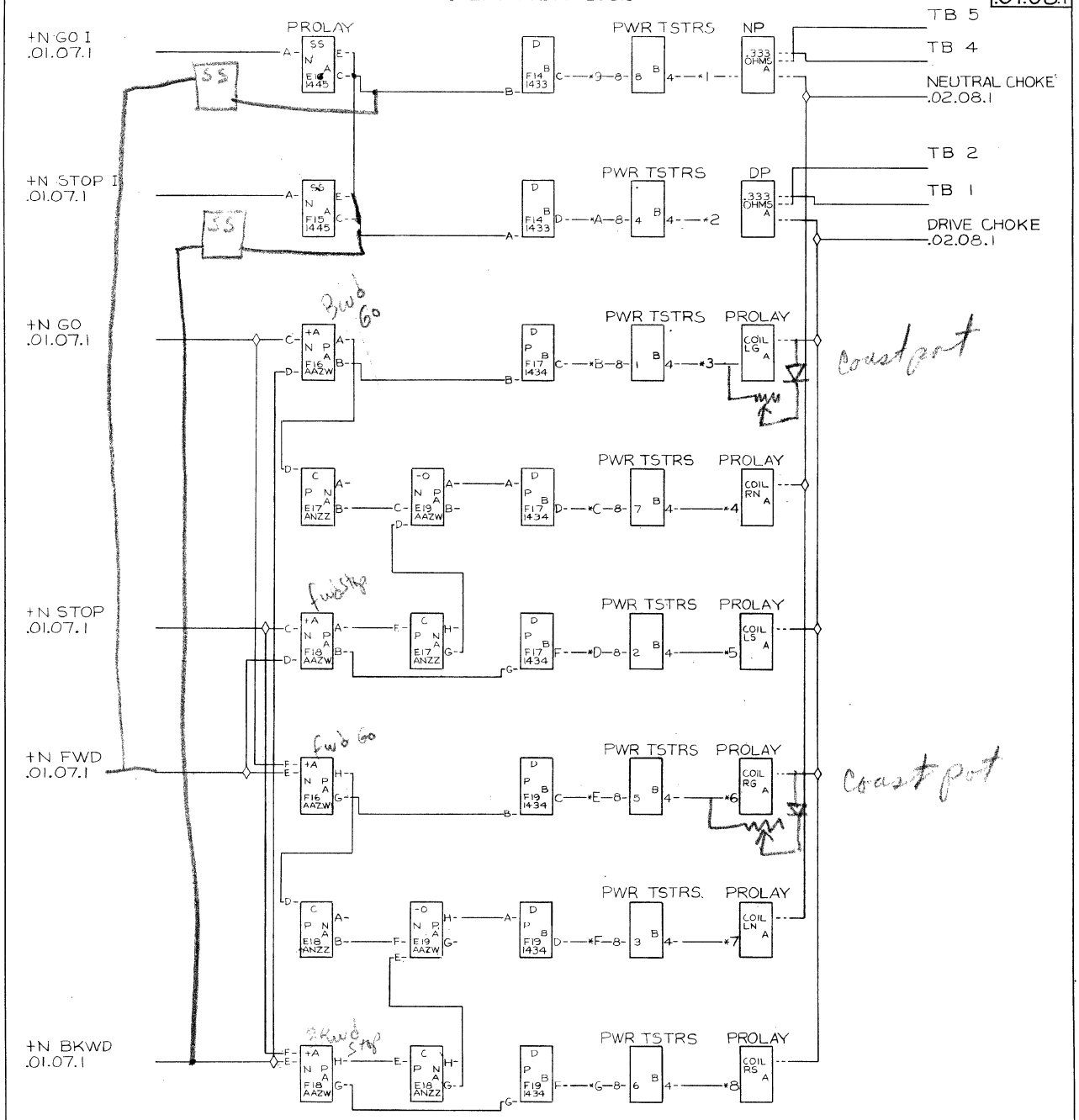


*1—IXD 24F *2—IXK 24G *3—45C.-D *4—45D -J- *5—45B. *6—45A. *7—IXM 24H

S.S turn on power trans to 4 MTS allow heavy current flow

PROLAY DRIVE LOGIC

.01.08.1



Start Rewind 2 ways
1. Start Rewind - Tape
2. Load Rewind Prog

.01.09.1

REWIND

-P ACT SELECT
.01.01.1

-P REW STATUS
.01.07.1

TC 37 ACT SEL+ REW
.00.02.1

To TAU
will be 9
same plan

-W REW + UNLOAD
.02.01.1

TAU
-N TC 9 START REWIND
.00.02.1

-P SEL + RDY
.01.01.1

SHIELD

PWR TSTR

+W REWIND PU
.02.02.1

02.01.1

-W MAN LD REW
.02.01.1

-P READ STATUS
.01.02.1

TAU
+P TC 39 REW + UNLOAD

SHIELD

+N ACT SELECT
.01.01.1

A-123

+W REW + UNLOAD PU
.02.02.1

+140V FILTERED
.02.08.1

H.S. AREA

+6V
.02.07.1

H.S. AREA

+P on H.S. area

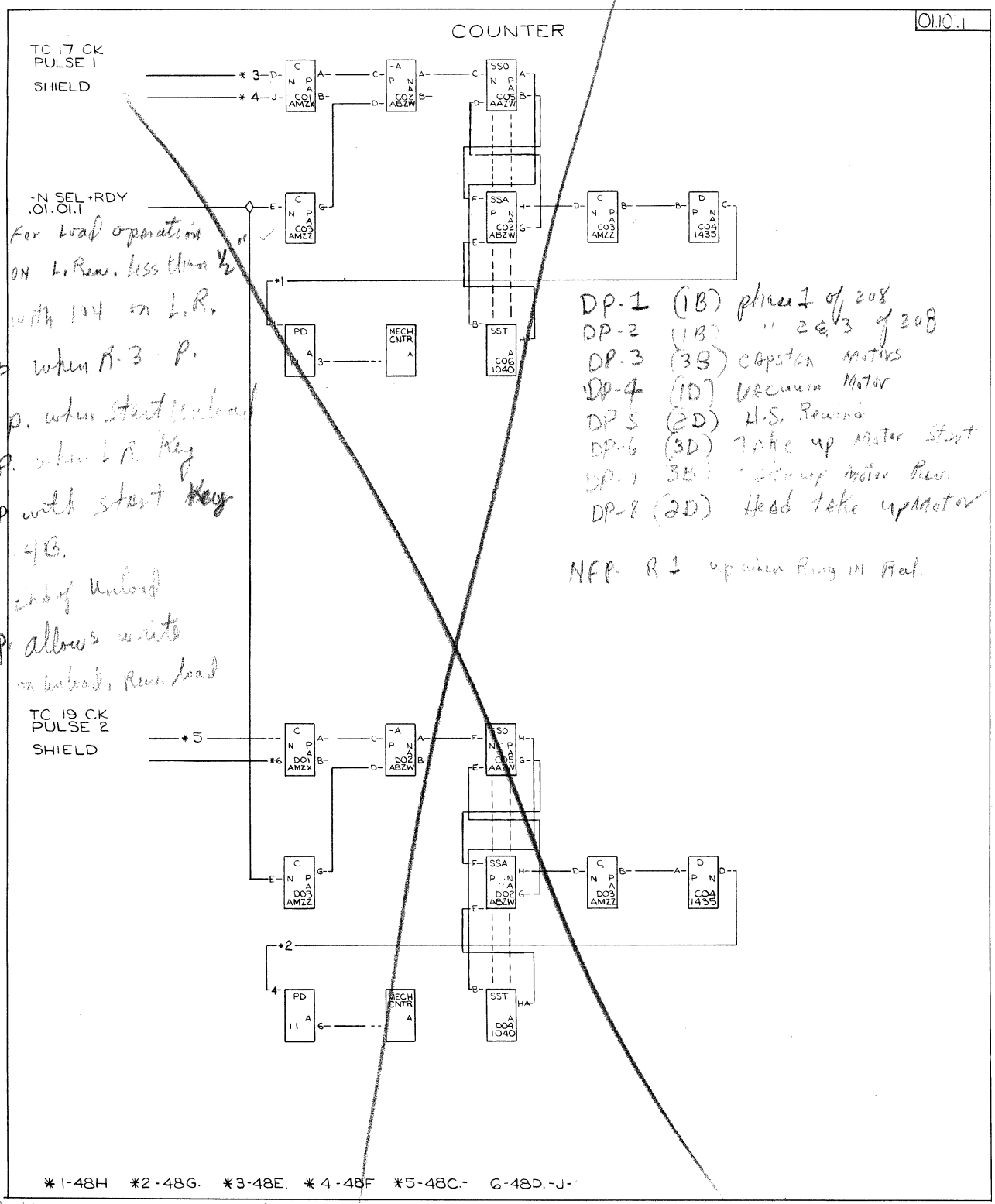
PWR TSTRS

+W HS AREA PU
.02.02.1

Faulty factor on Reverse

-12V
.02.07.1

*1--TP 0 6 --25H IXY --IIIK --1- *2--TP 0 6 --25G IXH --IIIP --4-
*3--37C *4--43G XK --IIIK --7- *5--IXC 36G
*6--TP 2 0.2--C- *7--TP 2 0.2--36H IXM --1VL ----
*8 --D- *9--37E --D-
*A--37F. --J- *B--1XU 25B *C --D-
*D --K- *E--XF 47C ----



R-3 P For Load operation "
R-4 P on L. Rew. less than ½"
R-9 P with 104 on L.R.
R 101 P when R-3 P.
R 102 P. when start pushed
R 104 P. when L.R. key
R 106 P with start key
R 107 4B.
R 109 ends Unload
R 112 P. allows writs
R 119 P on unload, Rew. load

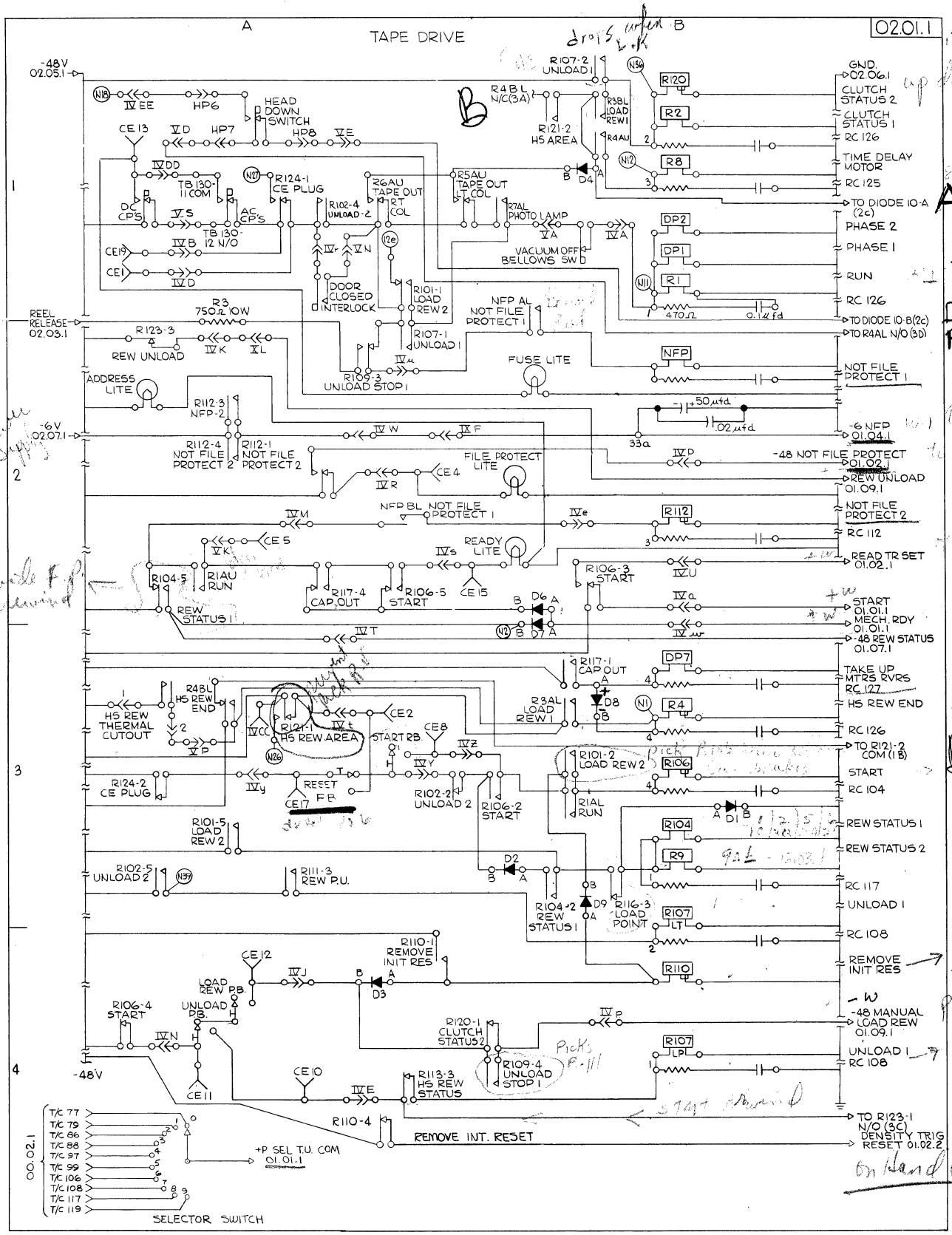
DP-1 (1B) phase 1 of 208
DP-2 (1B) " 2 & 3 of 208
DP-3 (3B) Capstan Motors
DP-4 (1D) Vacuum Motor
DP-5 (2D) H.S. Rewind
DP-6 (3D) Take up Motor Start
DP-7 (3B) Take up Motor Rev.
DP-8 (2D) Head take up Motor

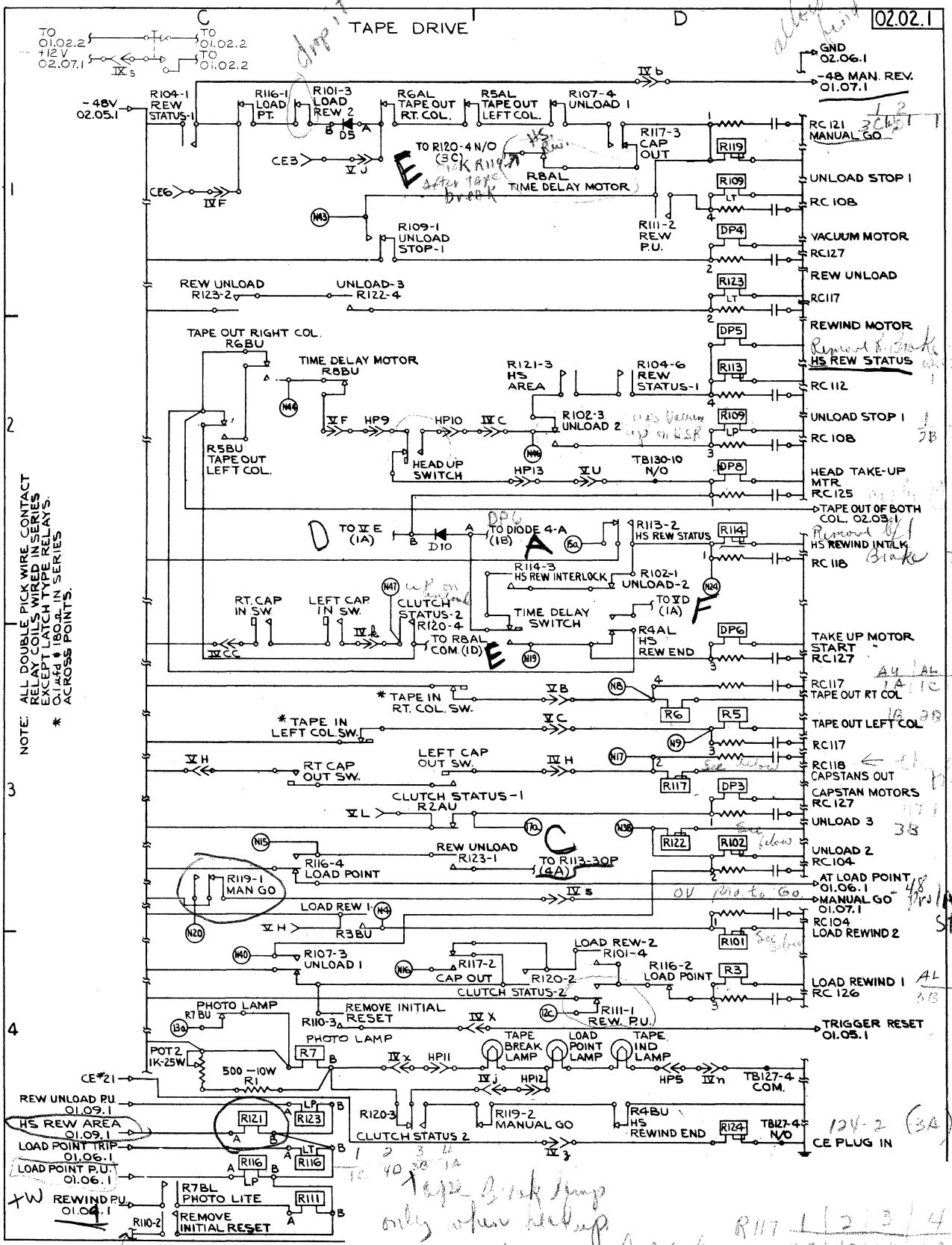
NFP. R 1 up when Ring IN Rel.

Reset Key
drops R-106 drops operationally ready
drops R-104 R9 Stops low speed rewind
Shunts R 121-1 Causes logic to stop the unit & load tape. Holding reset key will cause tape
Unit to stop after loading tape. Can't pick R 104 & R 9

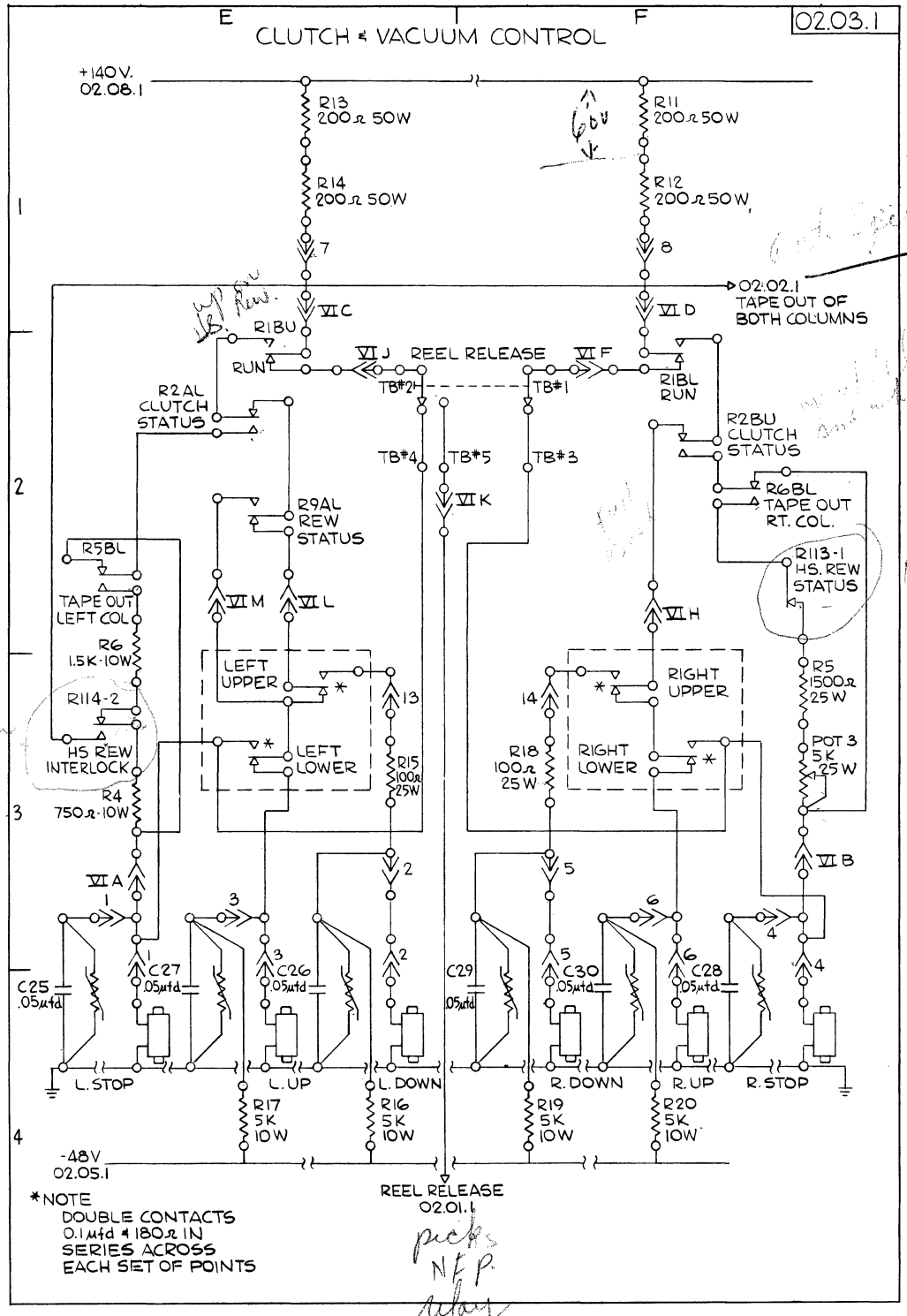
Load and reset tape indicator

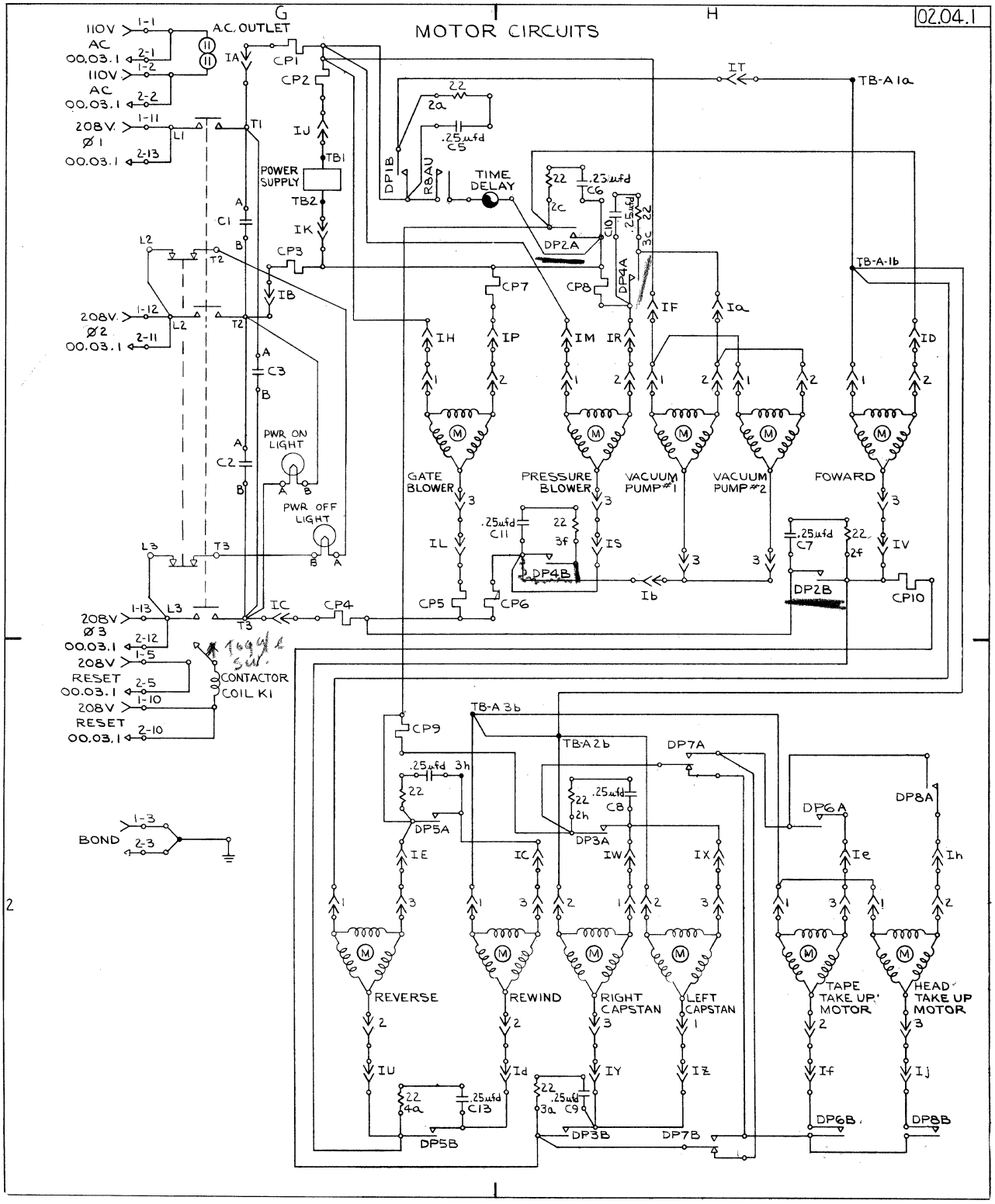
Cannot Stop load & Unload

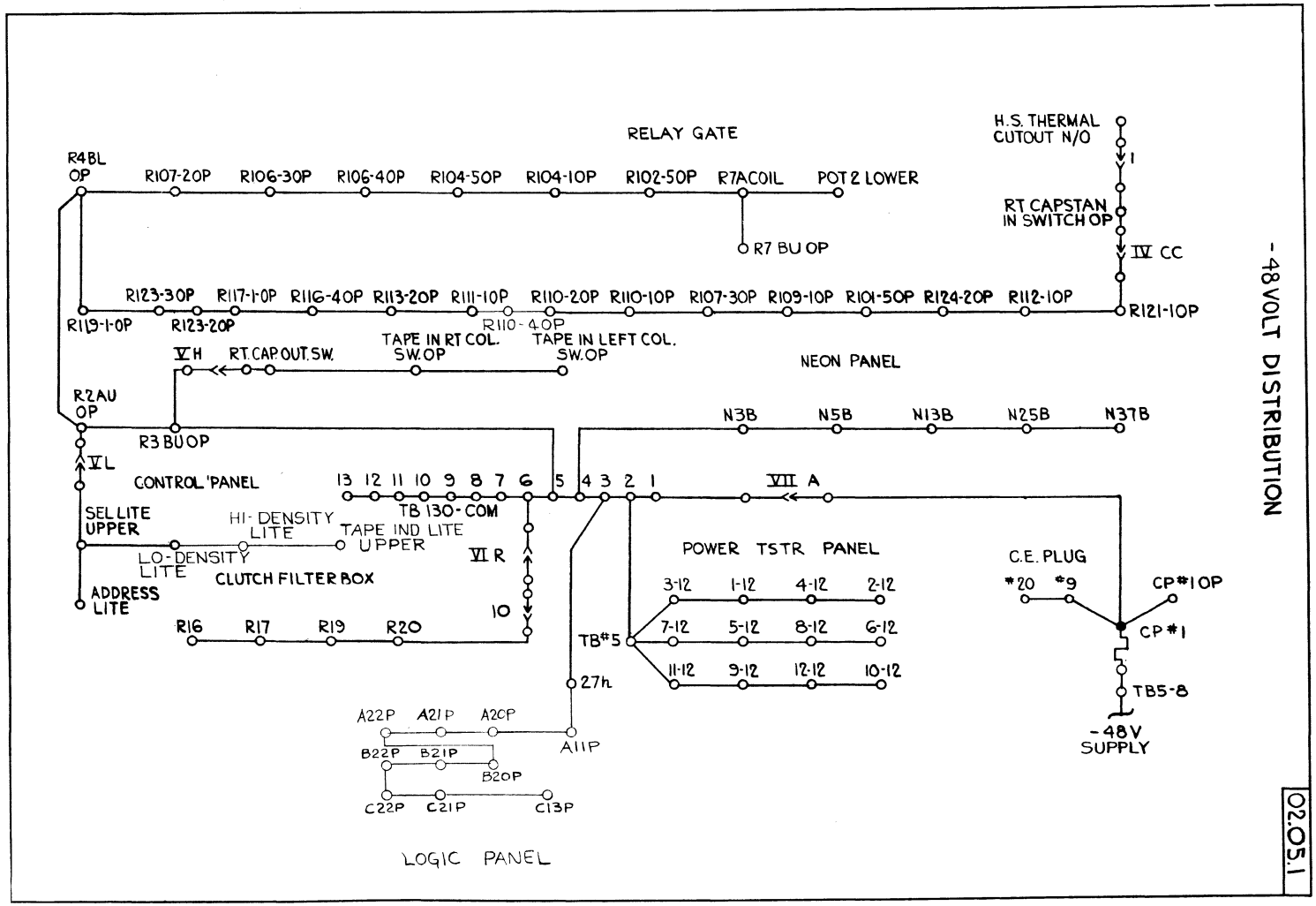

TAPE DRIVE
02.01.1
-48V 02.05.1
-6V 02.07.1
REEL RELEASE 02.03.1
GND 02.06.1
CLUTCH STATUS 2
CLUTCH STATUS 1
RC 126
TIME DELAY MOTOR
RC 125
TO DIODE 10-A (2c)
PHASE 2
PHASE 1
RUN
RC 126
TO DIODE 10-B(2c)
TO R4AL N/O (3D)
NOT FILE PROTECT 1
-6 NFP 01.04.1
-48 NOT FILE PROTECT 01.02.1
REW UNLOAD 01.09.1
NOT FILE PROTECT 2
RC 112
READ TR SET 01.02.1
START 01.01.1
MECH. RDY 01.01.1
-48 REW STATUS 01.07.1
TAKE UP MTRS RVRS
RC 127
HS REW END
RC 126
TO R121-2 COM (1B)
START
RC 104
REW STATUS 1
REW STATUS 2
RC 117
UNLOAD 1
RC 108
REMOVE INIT RES
-48 MANUAL LOAD REW 01.09.1
UNLOAD 1
RC 108
TO R123-1 N/O (3C) DENSITY TRIG RESET 01.02.2
REMOVE INT. RESET
+P SEL TU. COM 01.01.1
SELECTOR SWITCH
T/C 77
T/C 79
T/C 86
T/C 88
T/C 97
T/C 99
T/C 106
T/C 108
T/C 117
T/C 119
02.02.1
TAPE OUT RT COL
TAPE OUT LT COL
VACUUM OFF BELLOWS SW D
DOOR CLOSED INTERLOCK
FUSE LITE
FILE PROTECT LITE
ADDRESS LITE
READY LITE
HEAD DOWN SWITCH
HS REW THERMAL CUTOUT
HS REW AREA
START RB.
LOAD REW PB.
UNLOAD PB.
RESET
CE PLUG
TB 130-11 COM
TB 130-12 N/O
DC CPS
AC CPS
HS AREA
PHOTO LAMP
REW UNLOAD
REW STATUS 1
CAP OUT
LOAD REW 1
LOAD REW 2
UNLOAD 2
REW P.U.
REMOVE INIT RES
LOAD POINT
UNLOAD STOP 1
HS REW STATUS
NFP AL NOT FILE PROTECT 1
NFP BL NOT FILE PROTECT 1
NFP-2
NOT FILE PROTECT 2
R3 750Ω 10W
470Ω
0.1μfd
.02μfd
50μfd
33a

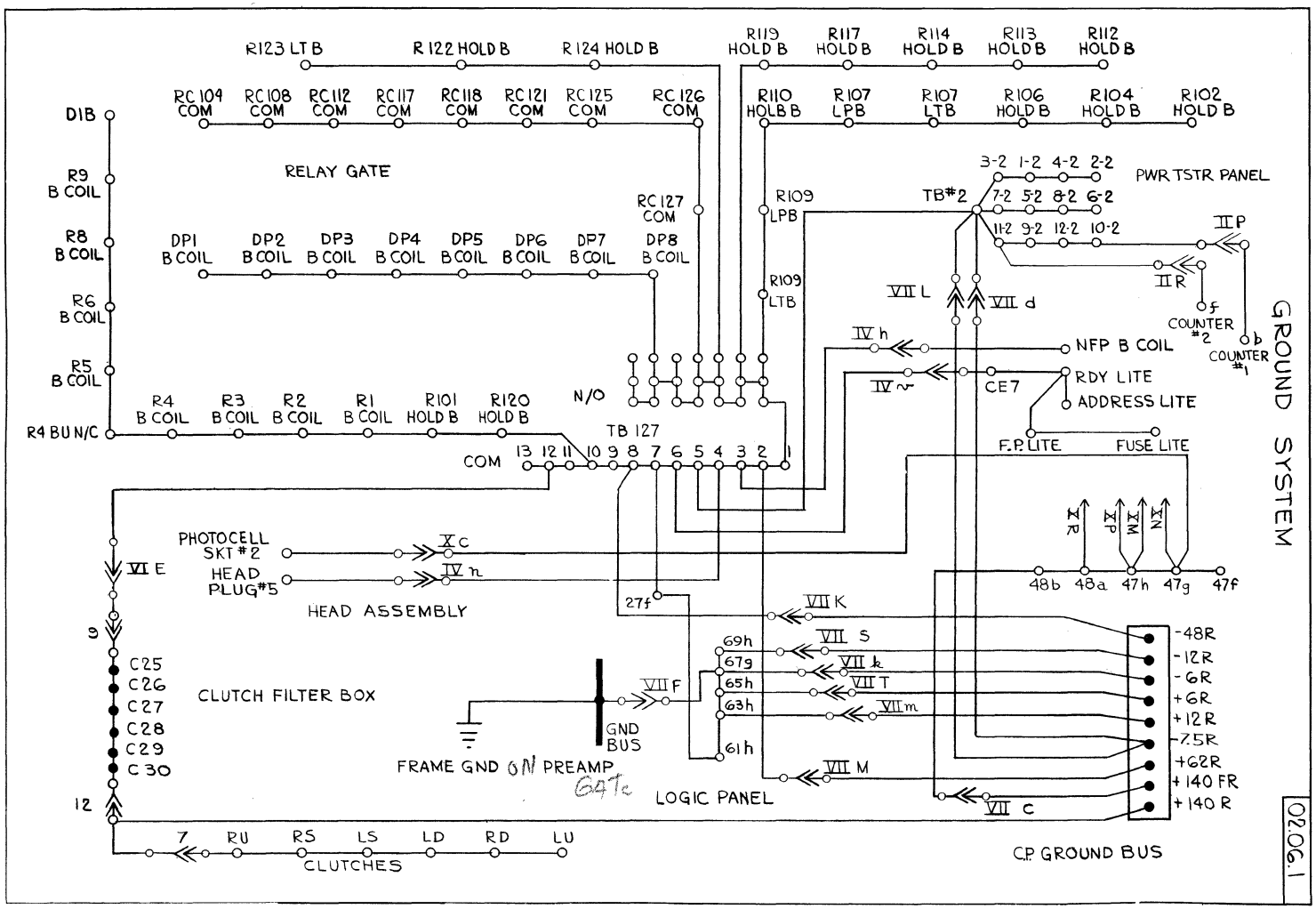

TAPE DRIVE
02.02.1
TO 01.02.2 +12V 02.07.1
TO 01.02.2
TO 01.02.2
GND 02.06.1
-48 MAN. REV. 01.07.1
-48V 02.05.1
R104-1 REW STATUS-1
R116-1 LOAD PT.
R101-3 LOAD REW 2
R6AL TAPE OUT RT. COL.
R5AL TAPE OUT LEFT COL.
R107-4 UNLOAD 1
R117-3 CAP OUT
RC 121 MANUAL GO
R119
R8AL TIME DELAY MOTOR
R109
UNLOAD STOP 1
RC 108
R109-1 UNLOAD STOP-1
R111-2 REW P.U.
DP4
VACUUM MOTOR RC127
REW UNLOAD R123-2
UNLOAD-3 R122-4
R123
REW UNLOAD RC117
REWIND MOTOR
TAPE OUT RIGHT COL. R6BU
TIME DELAY MOTOR R8BU
R121-3 HS AREA
R104-6 REW STATUS-1
DP5
R113
HS REW STATUS
RC 112
R5BU TAPE OUT LEFT COL.
HEAD UP SWITCH
HP9
HP10
HP13
R102-3 UNLOAD 2
TB130-10 N/O
DP8
HEAD TAKE-UP MTR RC125
TO IV E (1A)
D10
TO DIODE 4-A (1B)
TAPE OUT OF BOTH COL. 02.03.1
R113-2 HS REW STATUS
R114
HS REWIND INTLK RC 118
R114-3 HS REW INTERLOCK
R102-1 UNLOAD-2
TO IV D (1A)
RT. CAP IN SW.
LEFT CAP IN SW.
CLUTCH STATUS-2 R120-4
TIME DELAY SWITCH
TO R8AL COM. (1D)
R4AL HS REW END
DP6
TAKE UP MOTOR START RC127
NOTE: ALL DOUBLE PICK WIRE CONTACT RELAY COILS WIRED IN SERIES EXCEPT LATCH TYPE RELAYS. 0.1 µfd @ 180 VDC IN SERIES ACROSS POINTS.
* TAPE IN RT. COL. SW.
* TAPE IN LEFT COL. SW.
R6
R5
RC117 TAPE OUT RT COL
TAPE OUT LEFT COL
RC117
RT CAP OUT SW.
LEFT CAP OUT SW.
R117
DP3
RC118 CAPSTANS OUT
CAPSTAN MOTORS RC127
CLUTCH STATUS-1 R2AU
UNLOAD 3
R122
R102
UNLOAD 2 RC104
REW UNLOAD R123-1
TO R113-3OP (4A)
R116-4 LOAD POINT
AT LOAD POINT 01.06.1
R119-1 MAN GO
MANUAL GO 01.07.1
LOAD REW 1
R3BU
R101
RC104 LOAD REWIND 2
R107-3 UNLOAD 1
R117-2 CAP OUT
R120-2
LOAD REW-2 R101-4
R116-2 LOAD POINT
R3
LOAD REWIND 1 RC 126
CLUTCH STATUS-2
PHOTO LAMP R7BU
REMOVE INITIAL RESET
R110-3
R111-1 REW. P.U.
TRIGGER RESET 01.05.1
PHOTO LAMP
R7
POT 2 1K-25W
500 — 10W R1
HP11
TAPE BREAK LAMP
LOAD POINT LAMP
TAPE IND LAMP
HP5
HP12
TB127-4 COM.
CE*21
REW UNLOAD P.U. 01.09.1
HS REW AREA 01.09.1
LOAD POINT TRIP 01.06.1
LOAD POINT P.U. 01.06.1
REWIND P.U. 01.04.1
R121
R123
R116
R111
R7BL PHOTO LITE
REMOVE INITIAL RESET
R110-2
R120-3
R119-2 MANUAL GO
R4BU HS REWIND END
R124
TB127-4 N/O
CLUTCH STATUS 2
CE PLUG IN
-48 Return

Current 260 MA normally
Clutch Saturate at 500 MA



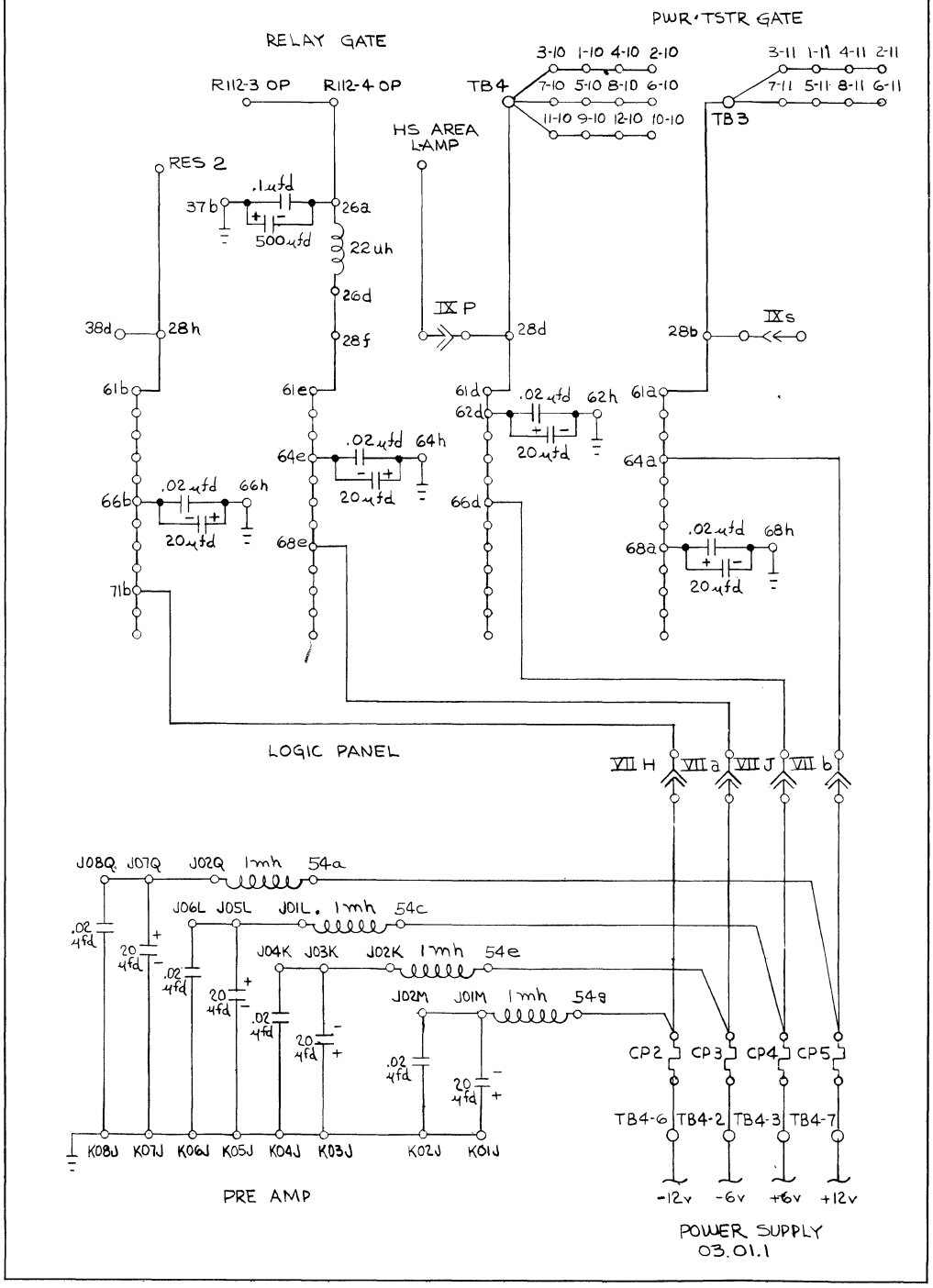

MOTOR CIRCUITS
02.04.1
G
H
110V AC 00.03.1
A.C. OUTLET
208V. Ø 1 00.03.1
208V. Ø 2 00.03.1
208V Ø 3 00.03.1
208V RESET 00.03.1
CONTACTOR COIL K1
BOND
POWER SUPPLY
TIME DELAY
PWR ON LIGHT
PWR OFF LIGHT
GATE BLOWER
PRESSURE BLOWER
VACUUM PUMP #1
VACUUM PUMP #2
FOWARD
REVERSE
REWIND
RIGHT CAPSTAN
LEFT CAPSTAN
TAPE TAKE UP MOTOR
HEAD TAKE UP MOTOR
TB-A 1a
TB-A 1b
TB-A 2b
TB-A 3b
DP1B
DP2A
DP2B
DP3A
DP3B
DP4A
DP4B
DP5A
DP5B
DP6A
DP6B
DP7A
DP7B
DP8A
DP8B
CP1
CP2
CP3
CP4
CP5
CP6
CP7
CP8
CP9
CP10
TB1
TB2
C1
C2
C3
C5
C6
C7
C8
C9
C10
C11
C13
.25 µfd
22
1-1
1-2
1-10
1-11
1-12
1-13
2-1
2-2
2-3
2-5
2-10
2-11
2-12
2-13


RELAY GATE
H.S. THERMAL CUTOUT N/O
R4BL OP
R107-20P
R106-30P
R106-40P
R104-50P
R104-10P
R102-50P
R7A COIL
POT 2 LOWER
R7 BU OP
RT CAPSTAN IN SWITCH OP
IV CC
R123-30P
R117-10P
R116-40P
R113-20P
R111-10P
R110-20P
R110-10P
R107-30P
R109-10P
R101-50P
R124-20P
R112-10P
R121-10P
R119-10P
R123-20P
R110-40P
TAPE IN RT COL. SW. OP
TAPE IN LEFT COL. SW. OP
V H
RT. CAP. OUT. SW.
NEON PANEL
R2AU OP
R3 BU OP
N3B
N5B
N13B
N25B
N37B
V L
CONTROL PANEL
13 12 11 10 9 8 7 6 5 4 3 2 1
VII A
TB 130-COM
SEL LITE UPPER
HI-DENSITY LITE
TAPE IND LITE UPPER
LO-DENSITY LITE
CLUTCH FILTER BOX
VI R
ADDRESS LITE
10
R16
R17
R19
R20
POWER TSTR PANEL
3-12
1-12
4-12
2-12
TB#5
7-12
5-12
8-12
6-12
11-12
9-12
12-12
10-12
C.E. PLUG
#20
#9
CP#10P
CP#1
TB5-8
-48V SUPPLY
27h
A22P
A21P
A20P
A11P
B22P
B21P
B20P
C22P
C21P
C13P
LOGIC PANEL
-48 VOLT DISTRIBUTION
02.05.1


R123 LT B
R 122 HOLD B
R 124 HOLD B
R119 HOLD B
R117 HOLD B
R114 HOLD B
R113 HOLD B
R112 HOLD B
RC 104 COM
RC 108 COM
RC 112 COM
RC 117 COM
RC 118 COM
RC 121 COM
RC 125 COM
RC 126 COM
R110 HOLB B
R107 LPB
R107 LTB
R106 HOLD B
R104 HOLD B
R102 HOLD B
D1B
R9 B COIL
R8 B COIL
R6 B COIL
R5 B COIL
R4 BU N/C
RELAY GATE
RC 127 COM
DP1 B COIL
DP2 B COIL
DP3 B COIL
DP4 B COIL
DP5 B COIL
DP6 B COIL
DP7 B COIL
DP8 B COIL
R109 LPB
R109 LTB
N/O
R4 B COIL
R3 B COIL
R2 B COIL
R1 B COIL
R101 HOLD B
R120 HOLD B
TB 127
COM
13 12 11 10 9 8 7 6 5 4 3 2 1
TB#2
3-2 1-2 4-2 2-2
7-2 5-2 8-2 6-2
11-2 9-2 12-2 10-2
PWR TSTR PANEL
II P
II R
f COUNTER #2
b COUNTER #1
VII L
VII d
IV h
IV n
NFP B COIL
CE7
RDY LITE
ADDRESS LITE
F.P. LITE
FUSE LITE
XI R
XII P
XIII M
XIV N
48b 48a 47h 47g 47f
PHOTOCELL SKT #2
X C
HEAD PLUG #5
IV n
VI E
HEAD ASSEMBLY
27f
VII K
9
C25
C26
C27
C28
C29
C 30
12
CLUTCH FILTER BOX
69h
67g
65h
63h
61h
VII S
VII k
VII T
VII m
VII M
VII F
GND BUS
FRAME GND ON PREAMP
64Tc
LOGIC PANEL
VII C
-48R
-12R
-6R
+6R
+12R
-7.5R
+62R
+140 FR
+140 R
C.P. GROUND BUS
7 RU RS LS LD RD LU
CLUTCHES
GROUND SYSTEM
02.06.1

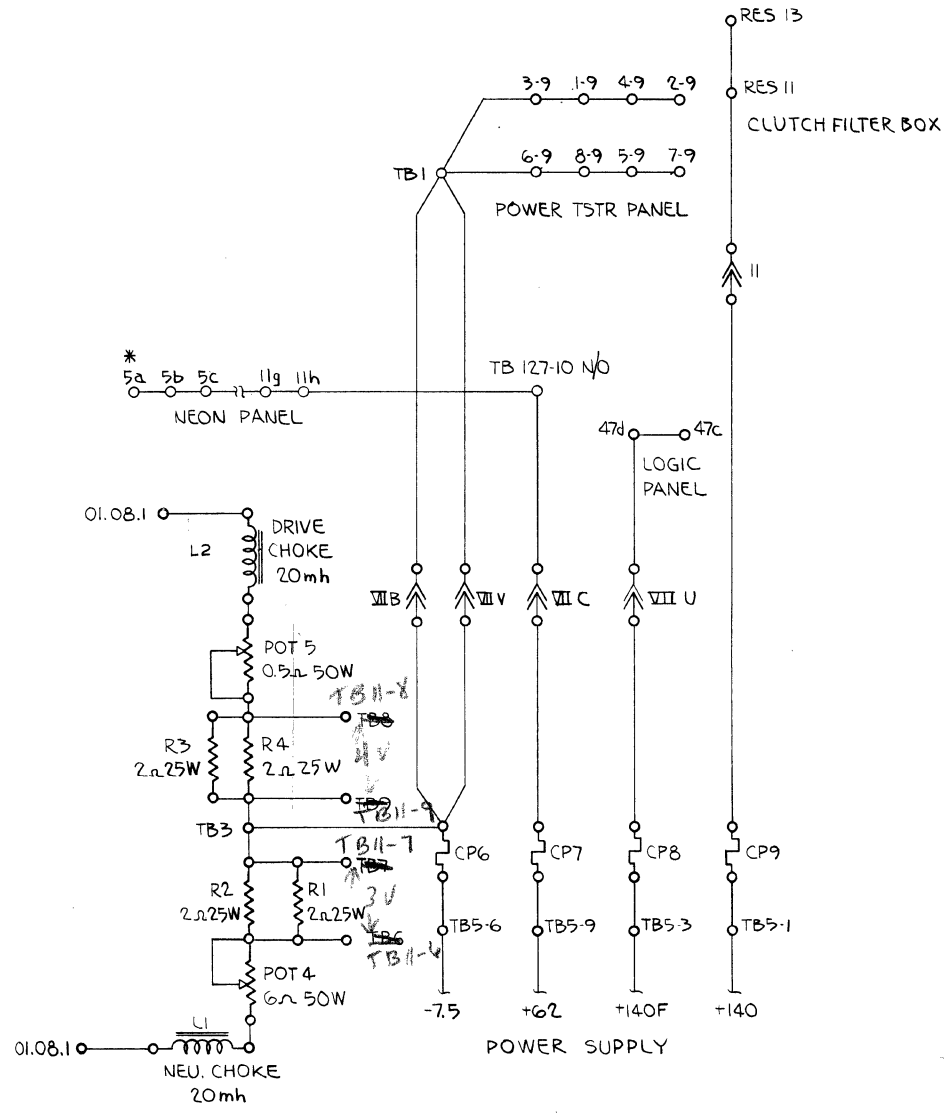
VOLTAGE DISTRIBUTION (+12, +6, -6, -12)

02.07.1

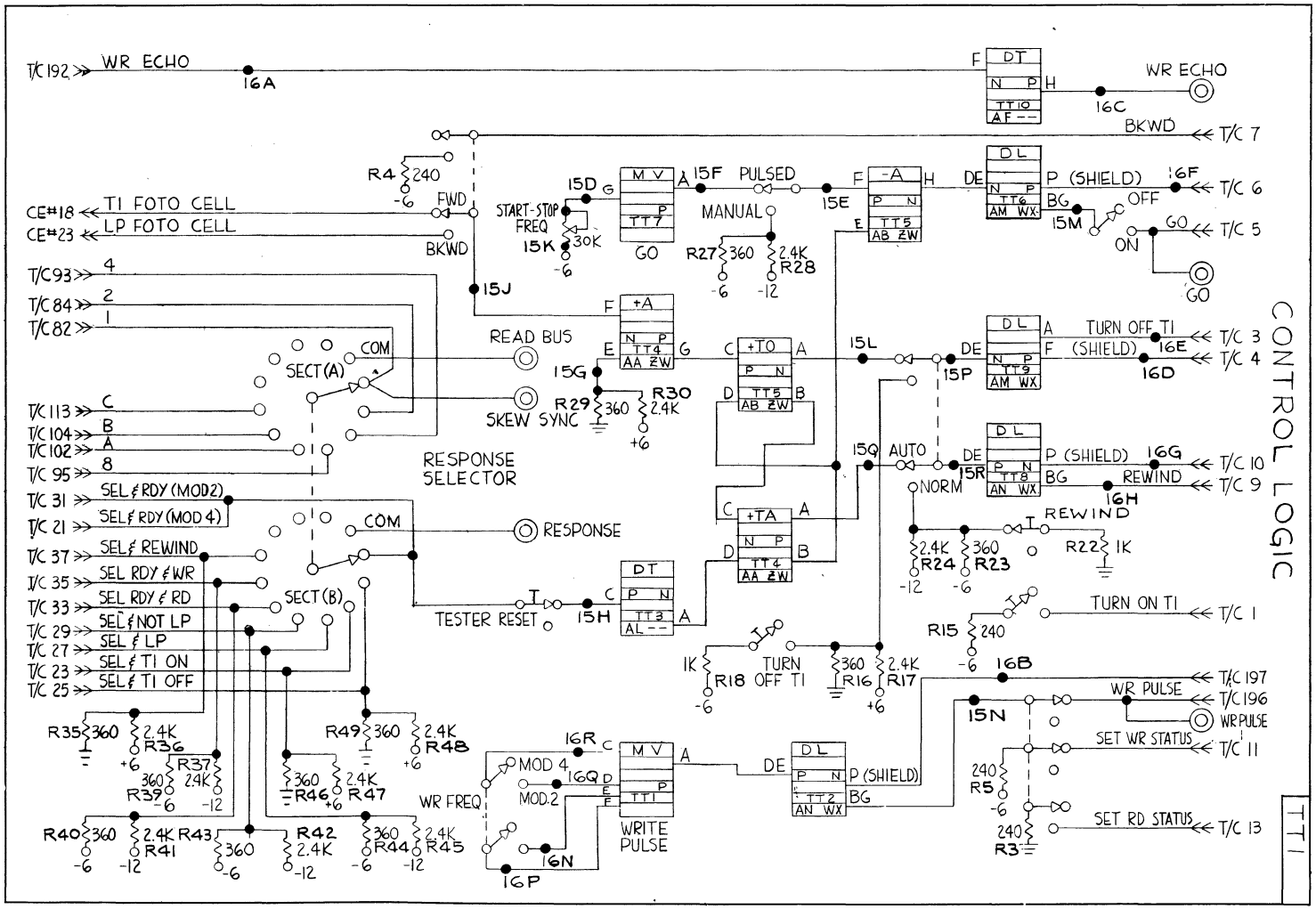


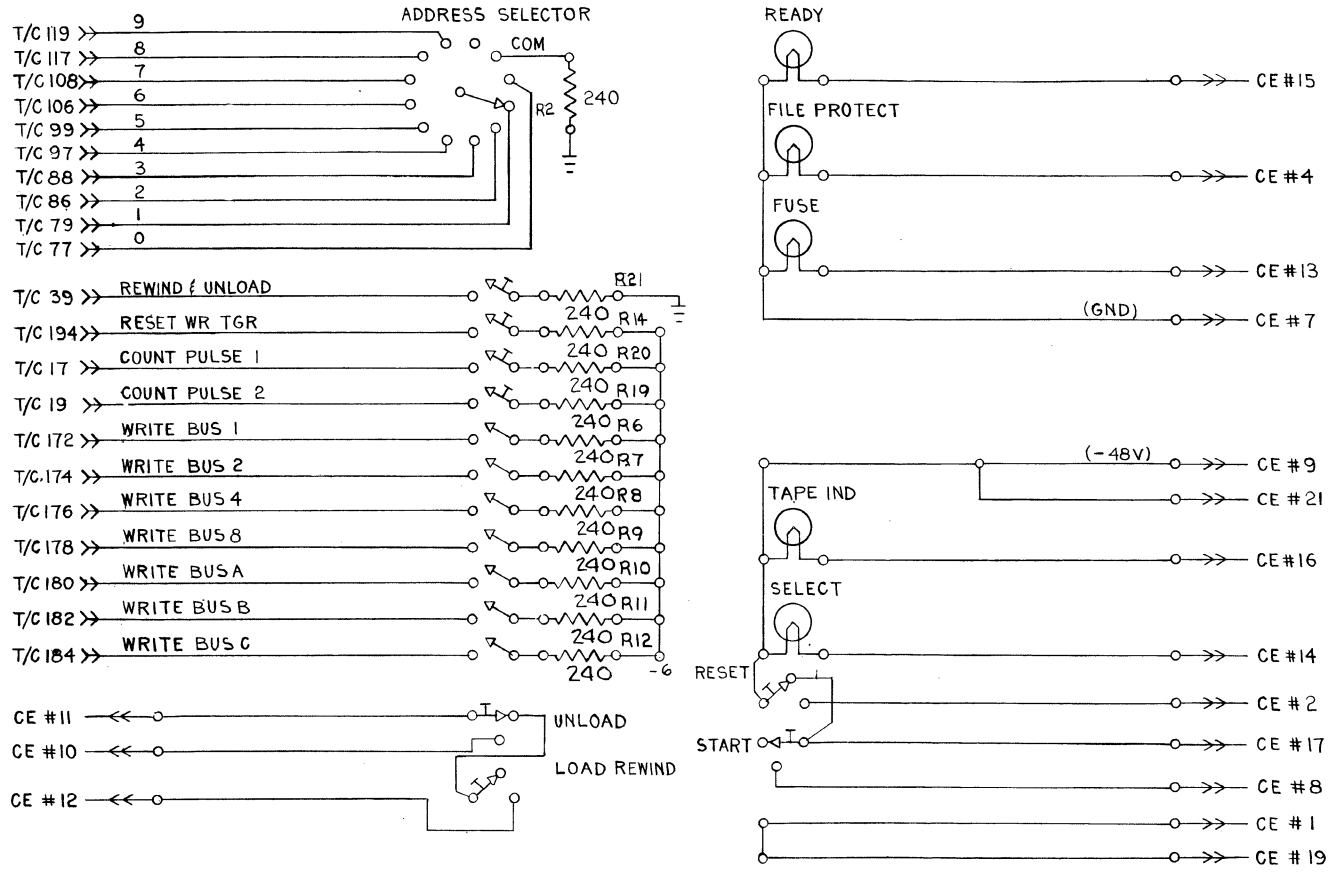
VOLTAGE DISTRIBUTION (-7.5, +62, +140F & +140)

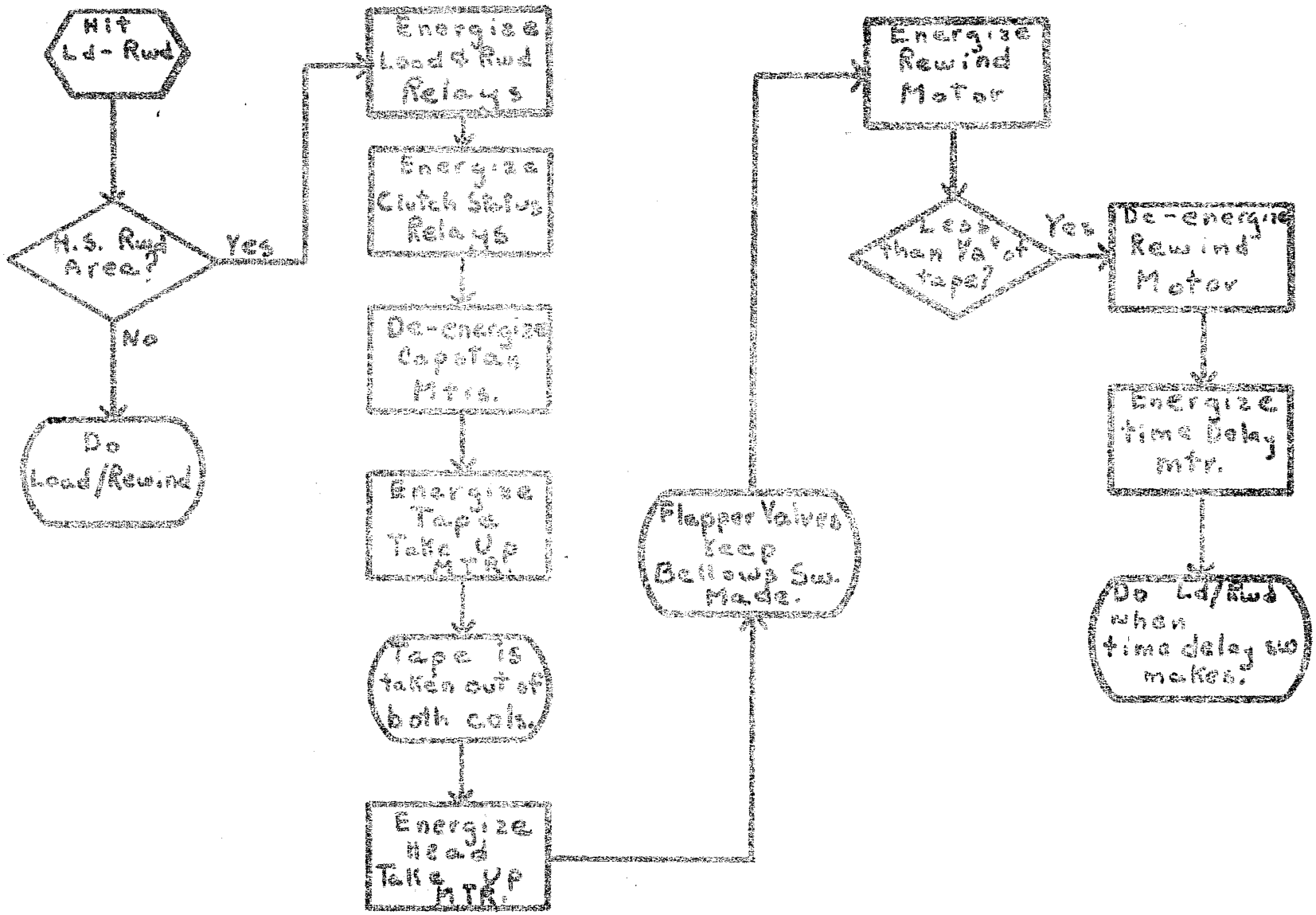
02.08.1



* JUMPERED FROM 5a TO 11h INCLUSIVE

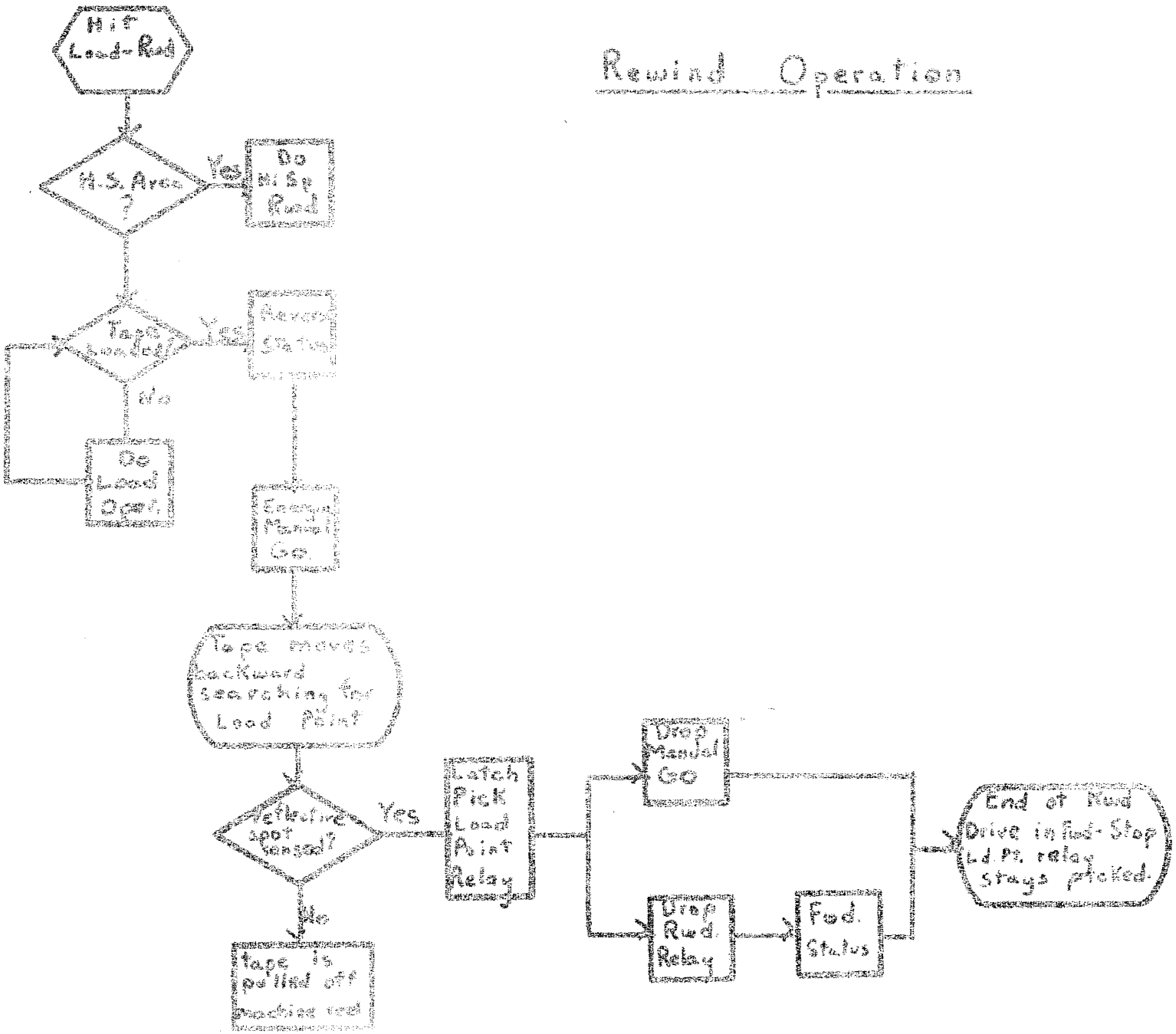

T/C 192
WR ECHO
16A
F
DT
N P
TT10
AF --
H
16C
WR ECHO
BKWD
T/C 7
R4 240
-6
FWD
BKWD
CE#18
TI FOTO CELL
CE#23
LP FOTO CELL
15D
G
M V
P
TT7
GO
A
15F
PULSED
START-STOP
FREQ
15K
30K
-6
MANUAL
R27 360
R28 2.4K
-6
-12
15E
F
-A
P N
TT5
AB ZW
E
DE
DL
P (SHIELD)
16F
T/C 6
BG
15M
OFF
ON
GO
T/C 5
GO
15J
T/C 93
T/C 84
T/C 82
4
2
1
F
+A
N P
TT4
AA ZW
READ BUS
E
G
15G
C
+TO
A
P N
D
TT5
AB ZW
B
15L
DE
15P
DL
A
TURN OFF TI
F
(SHIELD)
16E
T/C 3
T/C 4
16D
N P
TT9
AM WX
SECT(A)
COM
SKEW SYNC
R29 360
R30 2.4K
+6
T/C 113
T/C 104
T/C 102
T/C 95
C
B
A
8
RESPONSE
SELECTOR
15Q
AUTO
NORM
15R
DE
DL
P (SHIELD)
16G
T/C 10
BG
REWIND
T/C 9
16H
N P
TT8
AN WX
T/C 31
T/C 21
SEL & RDY (MOD2)
SEL & RDY (MOD 4)
C
+TA
A
N P
D
TT4
AA ZW
B
REWIND
T/C 37
SEL & REWIND
T/C 35
SEL RDY & WR
T/C 33
SEL RDY & RD
T/C 29
SEL & NOT LP
T/C 27
SEL & LP
T/C 23
SEL & TI ON
T/C 25
SEL & TI OFF
SECT(B)
COM
RESPONSE
TESTER RESET
I
C
DT
P N
TT3
AL --
15H
A
R24 2.4K
R23 360
-12
-6
R22 1K
TURN ON TI
T/C 1
R15 240
-6
16B
1K
R18
TURN
OFF TI
360
R16
2.4K
R17
+6
T/C 197
T/C 196
WR PULSE
WR PULSE
15N
SET WR STATUS
T/C 11
240
R5
-6
240
R3
SET RD STATUS
T/C 13
R35 360
2.4K
R36
+6
R37
360
2.4K
R39
-6
-12
R49 360
2.4K
R48
+6
360
R46
+6
2.4K
R47
R40 360
2.4K
R41
-6
-12
R43
360
-6
R42
2.4K
-12
360
R44
-6
2.4K
R45
-12
16R
C
MOD 4
16Q
D
MOD 2
E
F
WR FREQ
16N
16P
M V
P
TT1
WRITE
PULSE
A
DE
DL
P N
TT2
AN WX
P (SHIELD)
BG
CONTROL LOGIC
TT1

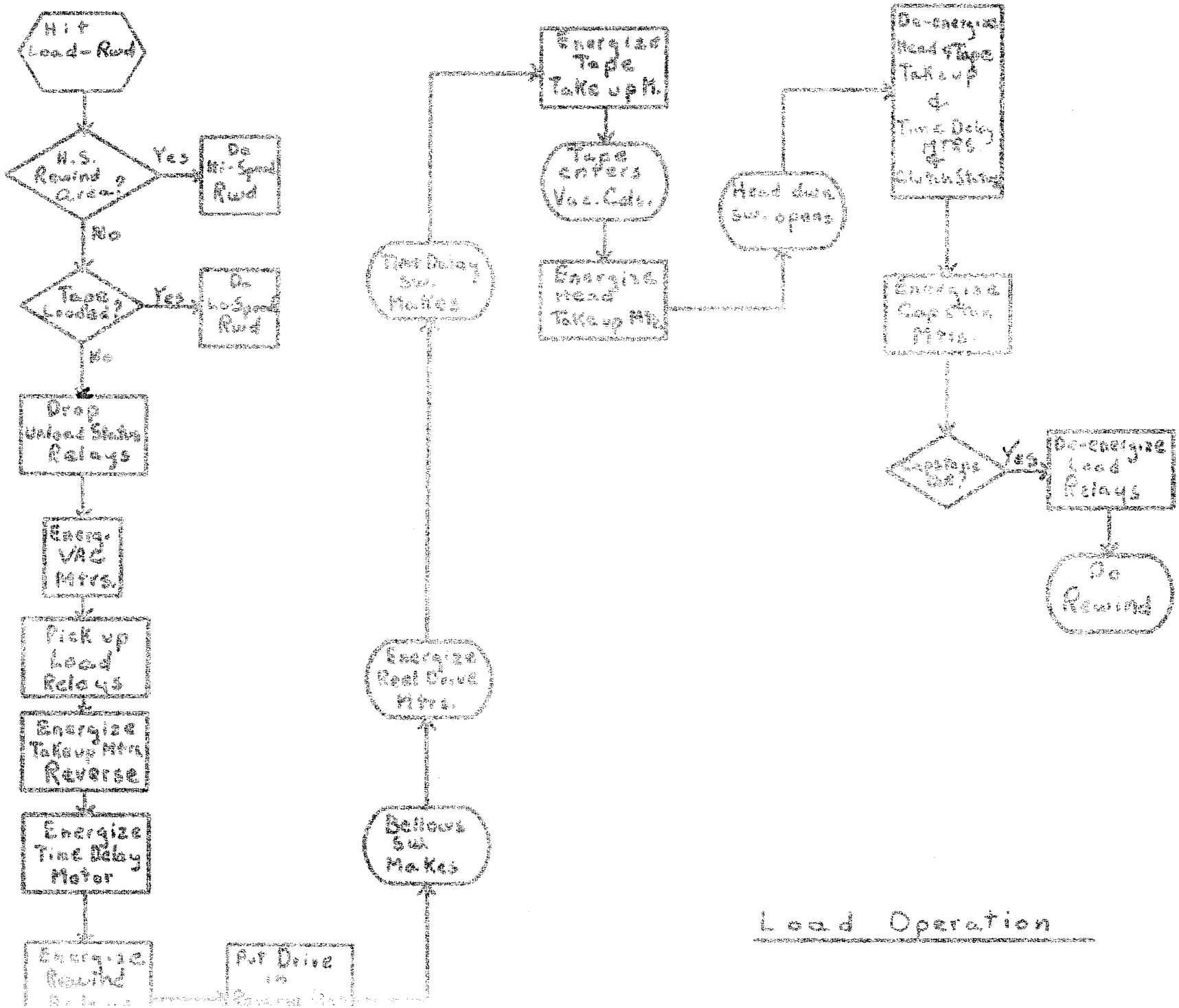

ADDRESS SELECTOR
T/C 119 >> 9
T/C 117 >> 8
T/C 108 >> 7
T/C 106 >> 6
T/C 99 >> 5
T/C 97 >> 4
T/C 88 >> 3
T/C 86 >> 2
T/C 79 >> 1
T/C 77 >> 0
COM
R2
240
T/C 39 >> REWIND & UNLOAD
T/C 194 >> RESET WR TGR
T/C 17 >> COUNT PULSE 1
T/C 19 >> COUNT PULSE 2
T/C 172 >> WRITE BUS 1
T/C 174 >> WRITE BUS 2
T/C 176 >> WRITE BUS 4
T/C 178 >> WRITE BUS 8
T/C 180 >> WRITE BUS A
T/C 182 >> WRITE BUS B
T/C 184 >> WRITE BUS C
R21
240 R14
240 R20
240 R19
240 R6
240 R7
240 R8
240 R9
240 R10
240 R11
240 R12
240
-6
CE #11
CE #10
CE #12
UNLOAD
LOAD REWIND
READY
CE #15
FILE PROTECT
CE #4
FUSE
CE #13
(GND)
CE #7
(-48V)
CE #9
CE #21
TAPE IND
CE #16
SELECT
CE #14
RESET
CE #2
START
CE #17
CE #8
CE #1
CE #19

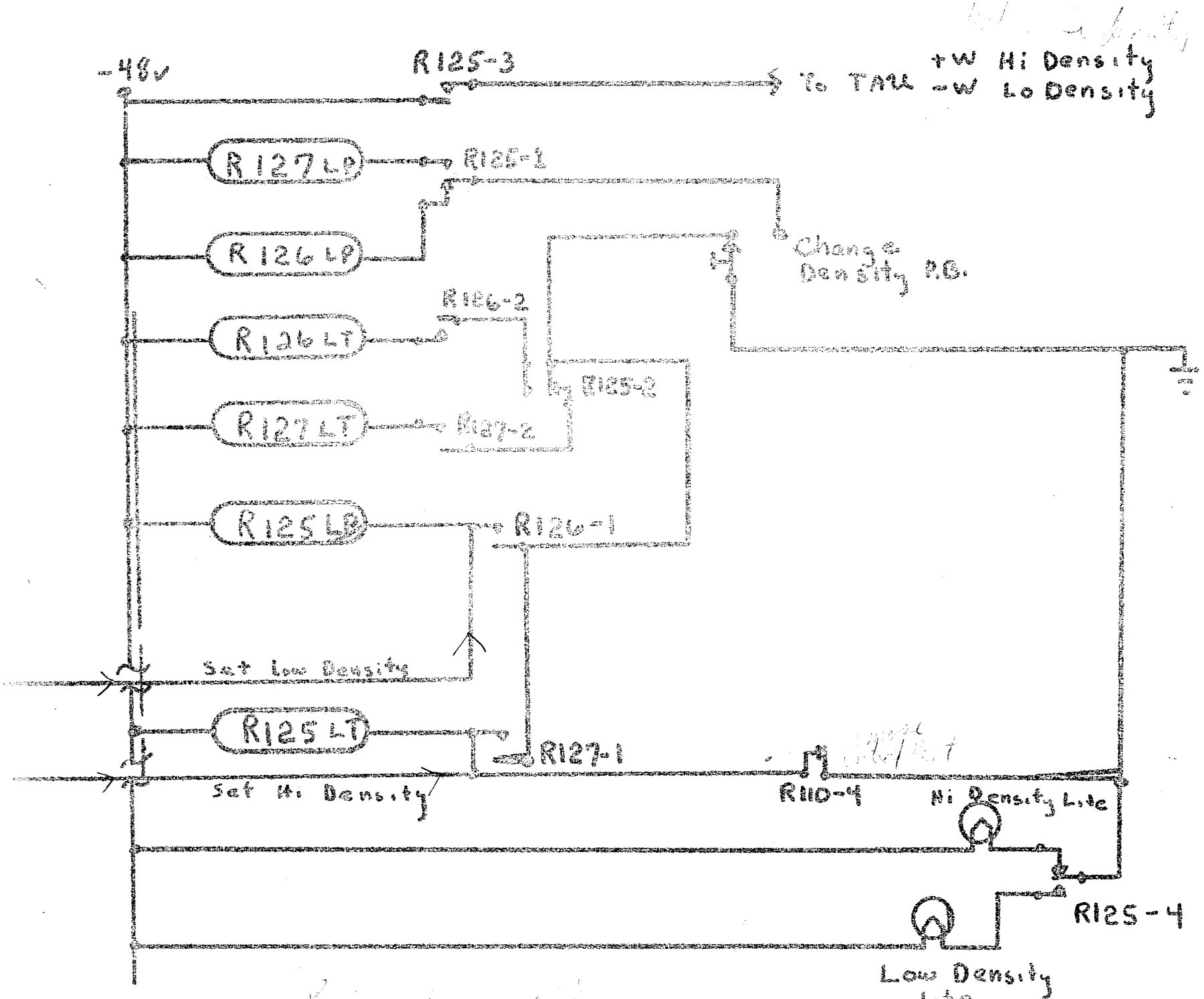


High Speed Rewind

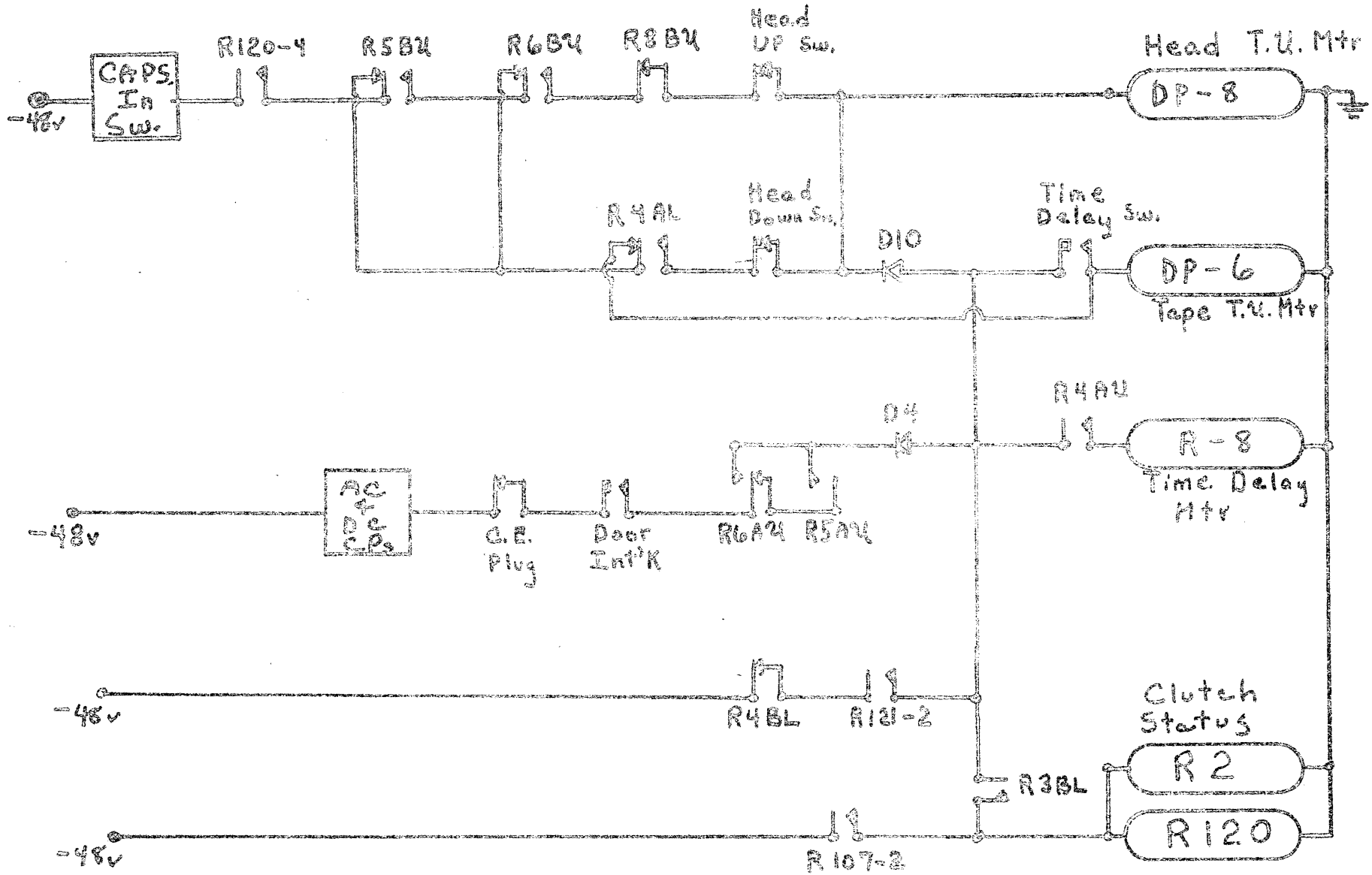
Rewind Operation




Hit Load-Rwd
N.S. Rewind Green?
Yes
De-Energize Rwd
No
Tape Loaded?
Yes
De-Energize Rwd
No
Drop Unused Station Relays
Energize VAC Mtrs.
Pick up Load Relays
Energize Take-up Mtrs. Reverse
Energize Tape Tens. Mtr.
Energize Rewind
Energize Tape Take Up M.
Tape enters Vac. Col.
Energize Reel Take up Mtr.
Energize Reel Tens. Mtrs.
Energize Reel Tens. Mtrs.
Release Sol. Brakes
Read Dual Sw. Opens
De-energize Reel Tape Take-up & Time Delay Relays Close
Energize Cap. Tens. Mtrs.
Tape Loaded?
Yes
De-energize Load Relays
Do Reading
Load Operation


-48v
R125-3
To TAU +W Hi Density -W Lo Density
R127 LP
R125-1
R126 LP
Change Density R.B.
R126-2
R126 LT
R125-2
R127 LT
R127-2
R125 LB
R126-1
Set Low Density
R125 LD
R127-1
Set Hi Density
R110-4
Hi Density Lite
R125-4
Low Density Lite

729 II/IV Relay Circuits



GLOSSARY OF TERMS - 729

RECORD - a series of bar magnets generated on tape (representing "characters") as a result of one write operation. Records can consist of any number of characters

FILE - a series of records on tape designating a complete list of data.

INTER-RECORD GAP - a 3/4" area of erased tape (Magnetized in one direction) which separates records on tape. It is generated by the mechanical delays in starting and stopping tape. An electronic delay at the beginning of every write operation contributes to the length of the gap.

BIT DENSITY - the number of characters per inch. It is a function of the passing speed of the tape drive and the frequency of the write pulse.

CHECK CHARACTER - a character written on tape at the end of every write operation as a result of resetting the write triggers. There is a gap of approximately four character intervals between it and the last character of a record.

BCD - Binary Coded Decimal; an even configuration of seven bits make up every tape character 1, 2, 4, 8 (numeric portion); A B (zone portion); C (check bit).

BLANK - No information (comparable to a blank column in a card) is represented on tape by a character made up of a "C" and "A" bit.

TAPE MARK - A special character written on tape (as a one character record) to designate the end of a file. It consists of a 1, 2, 4, and 8 bit.

SEGMENT MARK - A special character written on tape (as a one character record) to designate the end of a portion of a file. It consists of a C, A, 8, 4, 2, and 1 bit.

DELTA - A special character written on tape as part of a record. It is used to indicate a change from alphabetic to numerical mode and vice versa. It consists of a C, B, 8, 4, 2, and 1 bit.

RECORD MARK - A special character written on tape as part of a record. It consists of a C, A, 8, & 2 bit. It is used to separate blocks of information on some read & write operations.

SKEW - refers to the fact that the seven bits of a character are almost never in a line perpendicular to the edge of tape. This is because tape doesn't pass over the write heads in a straight line. The tape wobbles slightly. As a result, all the bits of a character are not read at precisely the same time.

1st BIT - because all the bits of a character aren't read at the same time, the first bit of a character is used to start a "skew timer" (electronic). The "skew timer" provides a delay or gate for reading the remaining bits of the character.

LONGITUDINAL REDUNDANCY CHECK - At the end of every read operation, a check is made to be sure an even number of bits was read from each of the seven tape tracks. The check character is included in the number of bits read.

FILE PROTECTION - a device on a tape drive to prevent writing on master tapes or any tapes unless desired.

LOAD POINT - a reflective spot placed on the front edge of tape about 10 feet from the beginning of tape. It is used to indicate the initial starting point for reading or writing on a reel of tape.

END OF TAPE MARKER - a reflective spot placed on the back edge of tape about 10 feet from the end of tape. It is used to indicate the physical end of tape on write operations only.

TAPE INDICATE - an indicating device used to designate the sensing of a tape mark character on read operations or the end of tape marker on write operations.

TAPE IS LOADED - refers to the condition of a tape drive when tape is in the vacuum columns and the head is down. It is a necessary condition for all read and write operations.

BACKSPACE - an operation which causes tape to be moved from one inter-record gap to another in a backward direction. In other words, tape is moved backward over one record.

REWIND - an operation referring to the movement of tape in backward direction. It is normally halted when load point is reached.

HI-SPEED REWIND - executed when a rewind is called for and there is more than 1/2" of tape on the machine. It is done with the tape drive in an "unloaded condition." When less than 1/2" of tape remains on the machine reel, the remainder of the rewind is done at low speed, with the tape drive in a loaded status.

UNLOAD CONDITION - the condition of the tape drive when tape is out of the columns and the head assembly is raised. The motors, except the capstan, remain energized.

UNLOAD STATUS - the status of the tape drive when it is in an "unload condition" and none of the motors are running, except for the gate blower motor.

PROLAY LUBRICATION SPEC.

The following parts on the left and right Prolay Assemblies are to be lubricated as specified below:

Nylon Pivot Shaft Part No. 528511	IBM #4 Oil Part No. 203453
Armature Pivot Shaft Part No. 530729	Aeroshell #14 Grease (Shell Oil Co.)
Arm Assembly Pivot Shaft Part No. 528539	Aeroshell #14 Grease (Shell Oil Co.)

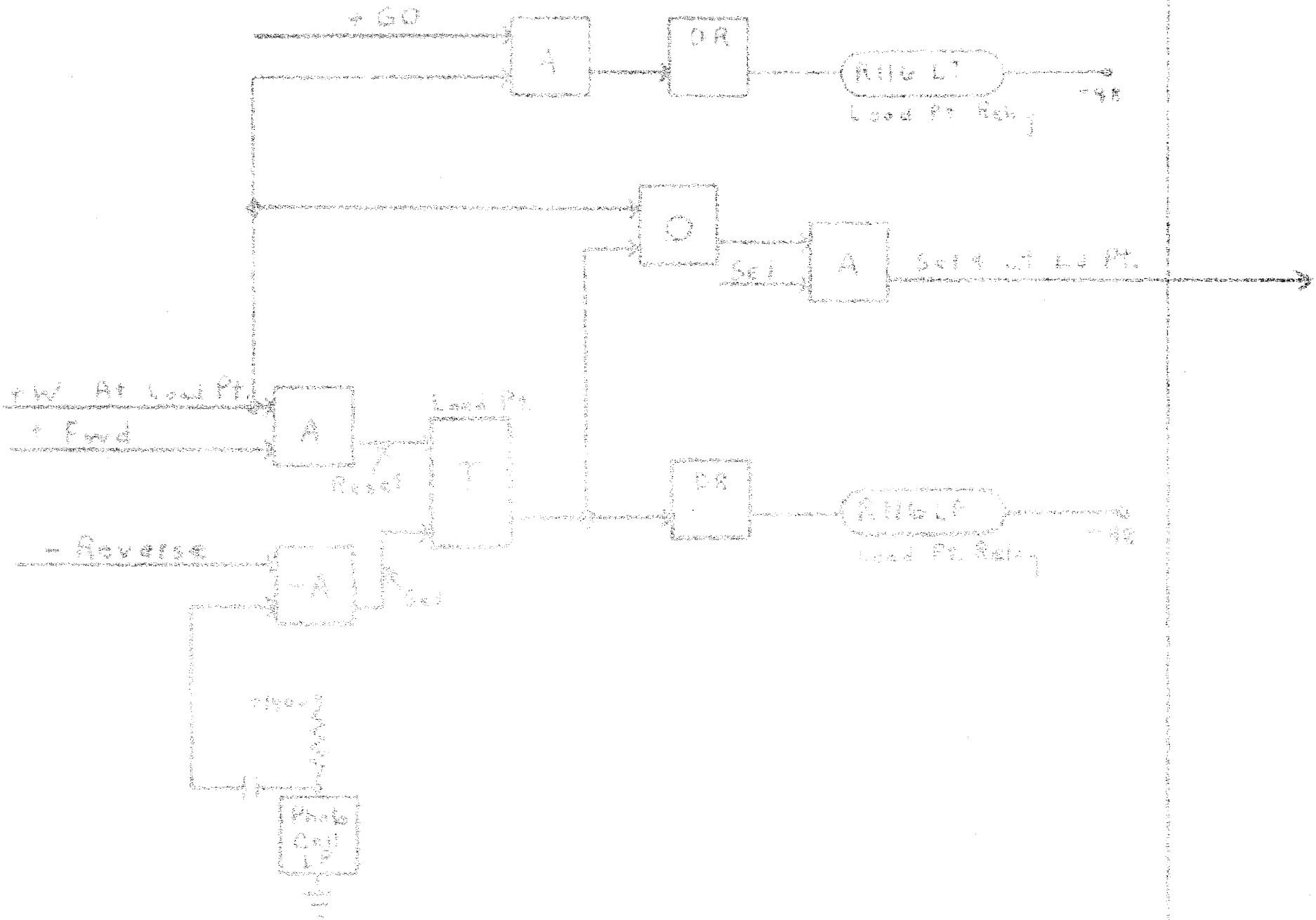
Procedure:

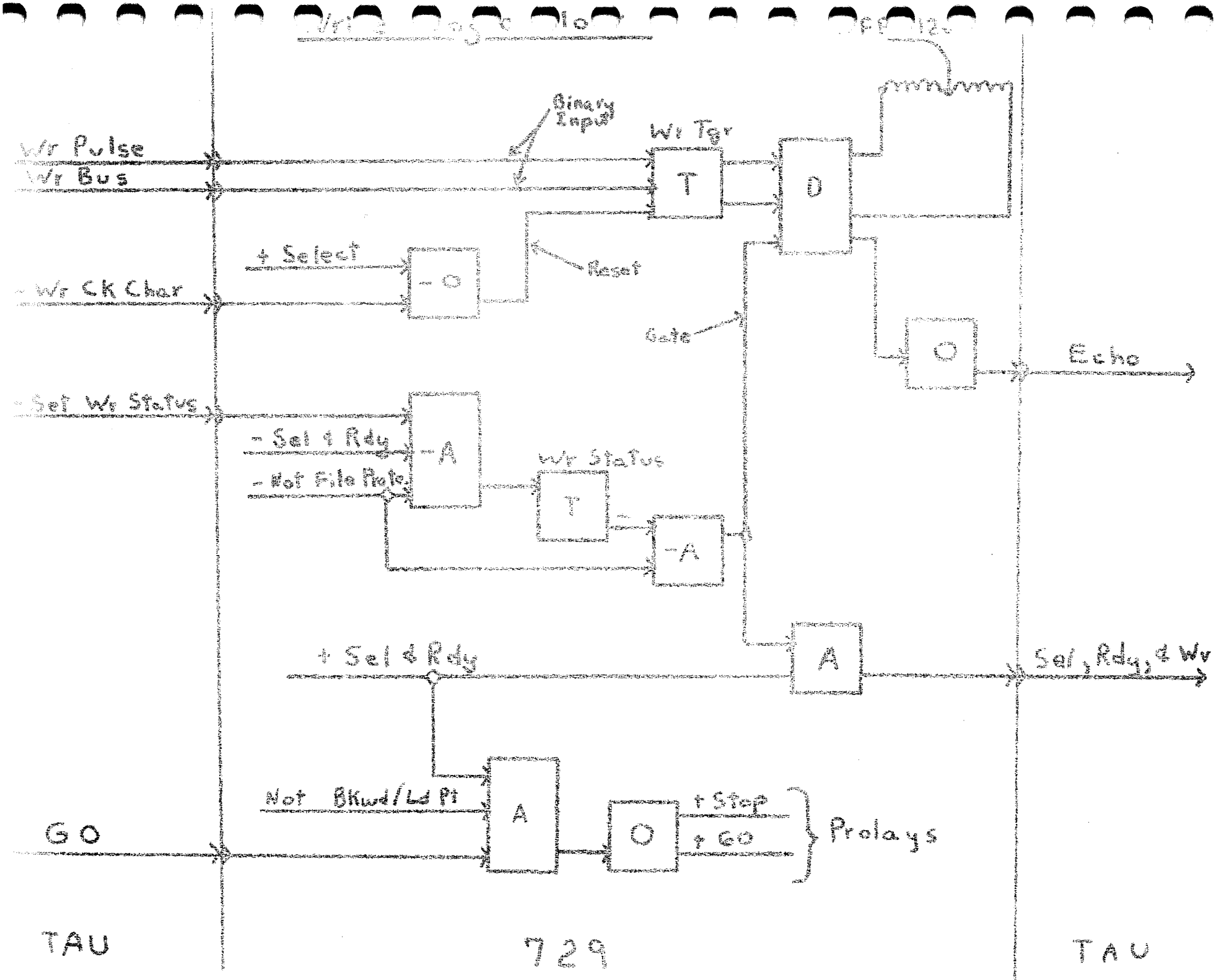
After removing the shaft, clean and coat with a thin film of the specified lubricant inserting the shaft into the bushing two or three times to deposit a film on the bushing. Re-assemble, taking care not to contaminate other parts with lubricant.

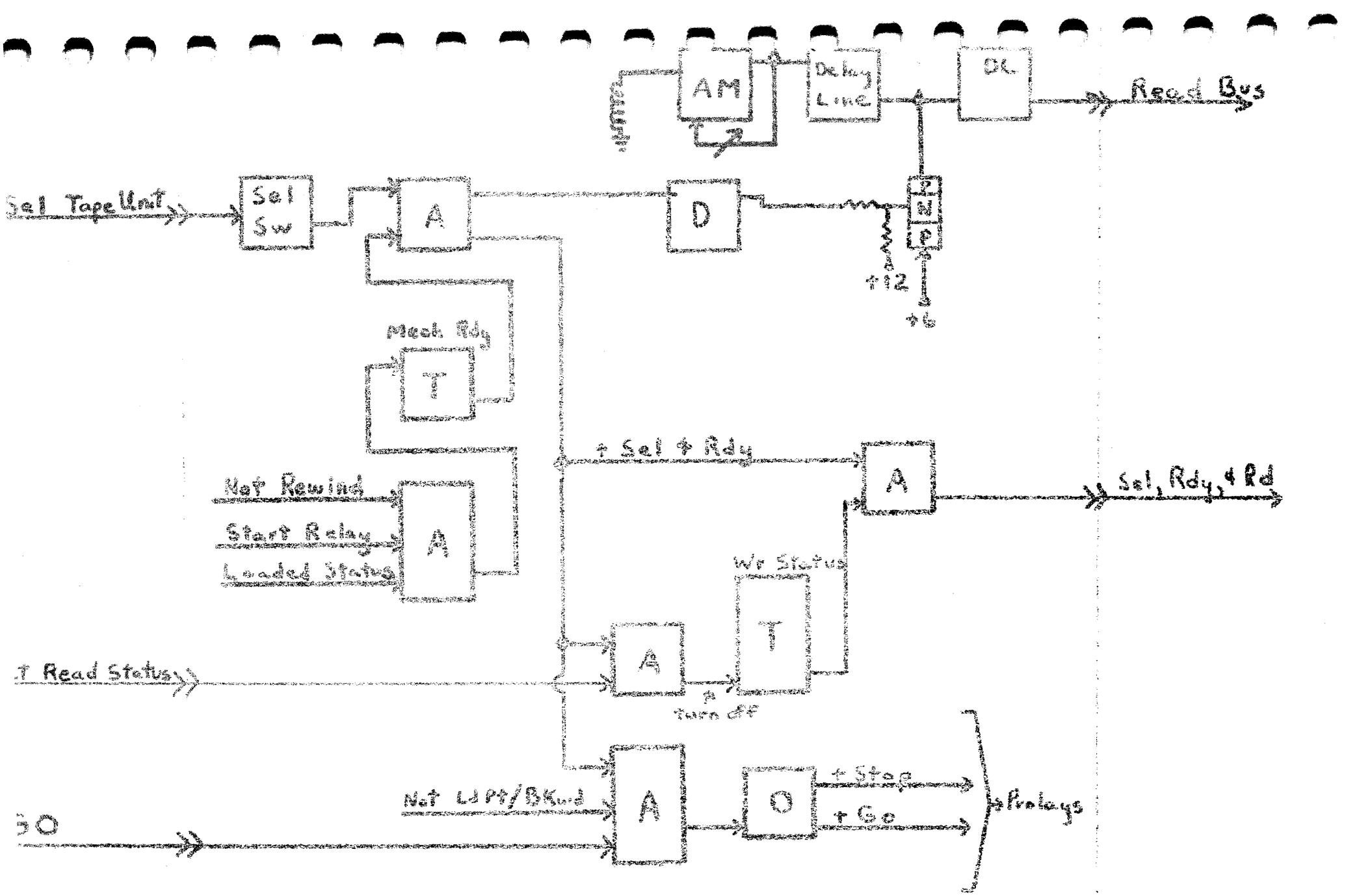
Frequency:

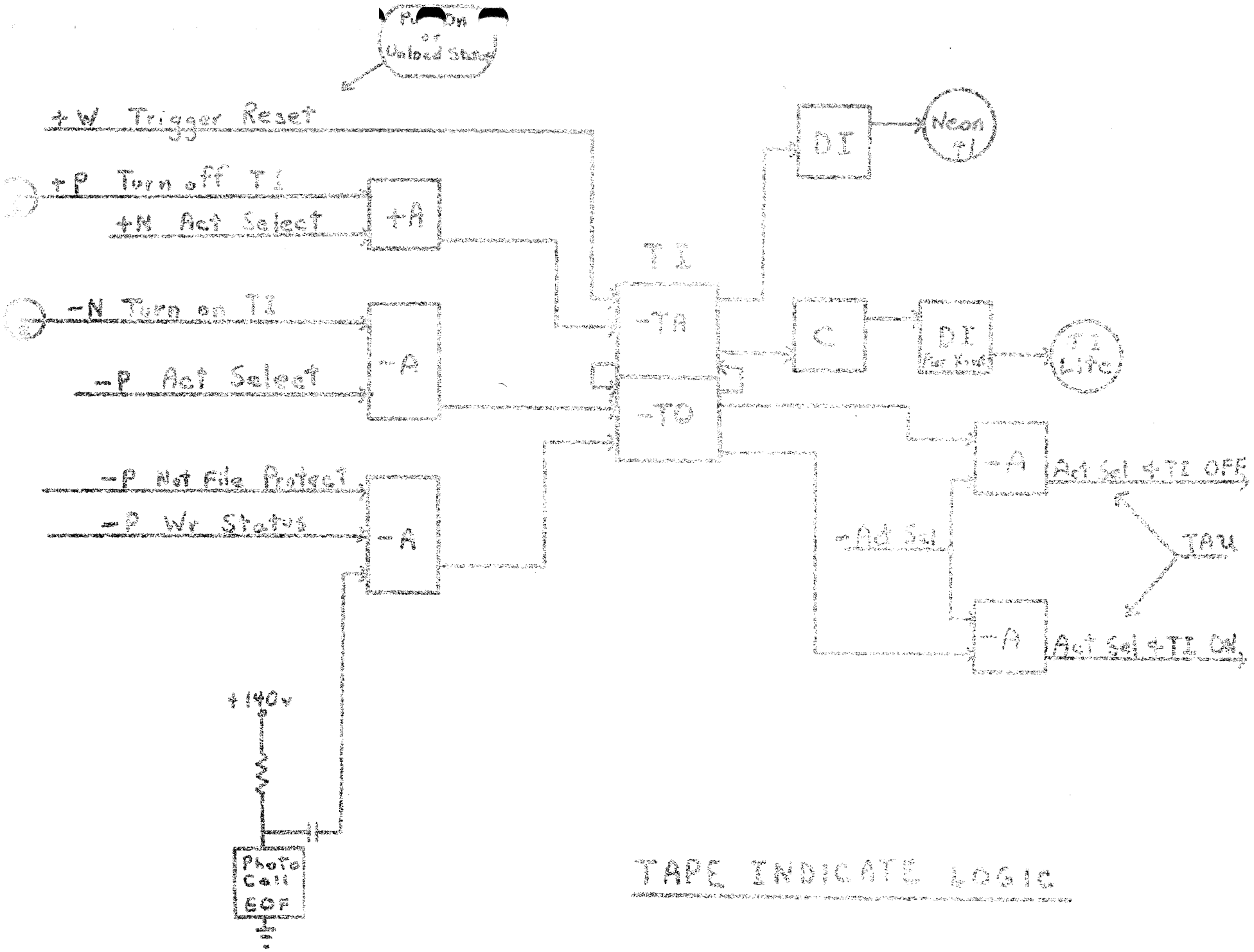
During the next scheduled individual Tape Drive PM period, lubricate the prolay assembly with Aeroshell #14 as per the above specification. After the initial lubrication, individual prolay lubrication requirements should be determined by use of the appropriate Inter-Record Gap Test.

System	I.R.G. Test
7051II	5TU04B
7070	7T03A
7090	9T55

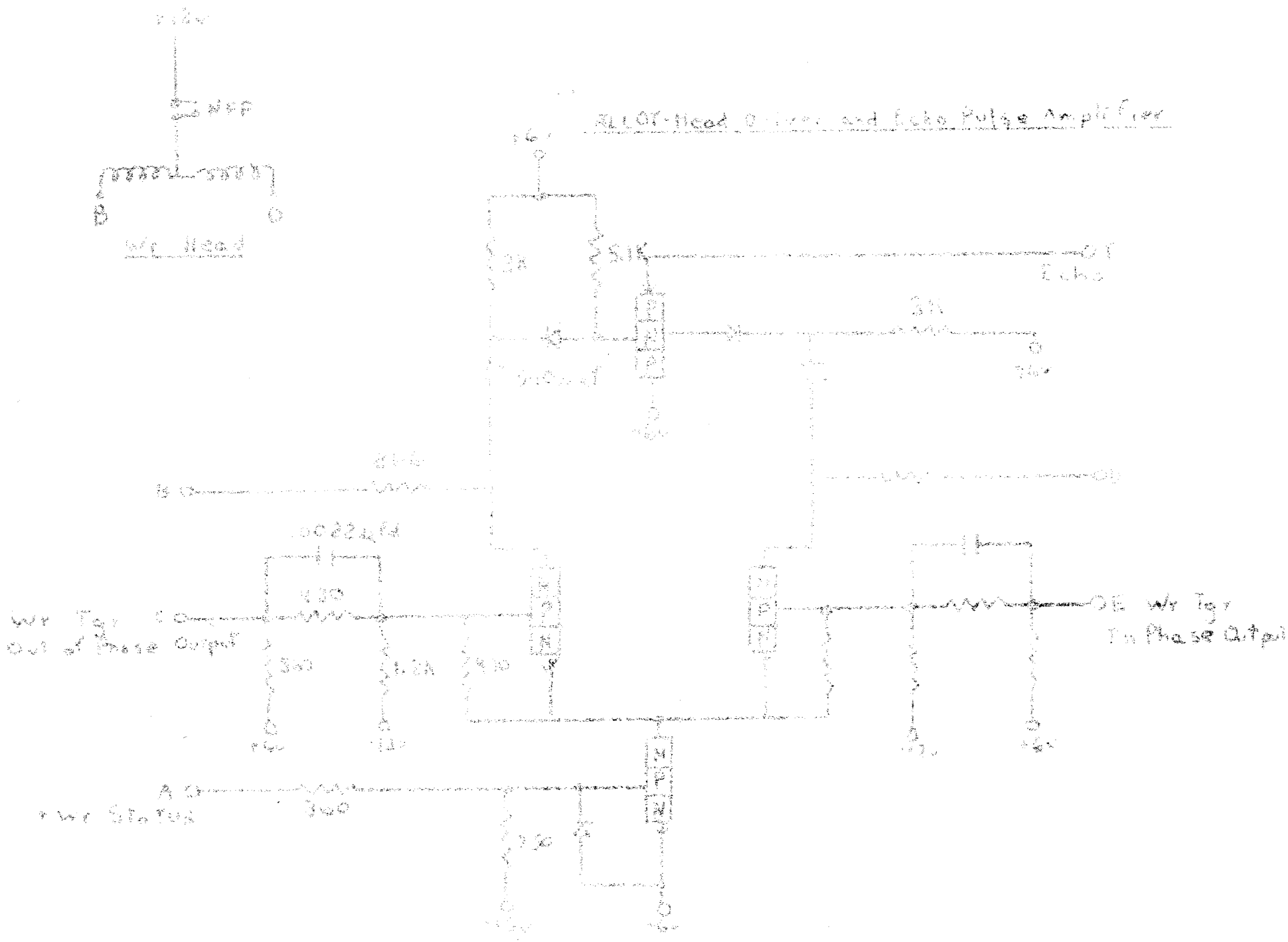

+GO
A
DR
Load Pt Relay
Set
A
T
Reset
Load Pt
+Fwd
-Reverse
-A
DR
Load Pt Relay


Wr Pulse
Wr Bus
Binary Input
Wr Tgr
T
D
+ Select
- Wr Clk Char
- Reset
Gate
O
Echo
- Set Wr Status
- Set Rdy
- Not Rdy Rets
A
Wr Status
T
- A
+ Set Rdy
A
Set Rdy & Wr
Not BKwd/Ld Pt
A
O
+ Step
+ Go
Pro days
GO


AM
Delay Line
DC
Read Bus
Sel Tape Unit
Sel Sw
A
D
Mech Rdy
T
+ Sel + Rdy
A
Sel, Rdy, + Rd
Not Rewind
Start Relay
Loaded Status
A
Wr Status
T
A
turn off
Read Status
Not Lst Pt/BKwd
A
O
+ Stop
+ Go
Relays
TAU
729
TAU



TAPE INDICATE LOGIC



TAPE IMPROVEMENT PACKAGE

Tape Unit Changes

1. Mechanical

a.	Head Wrap Angle	E. C. 247608	7-1/4°
b.	New H. Shield	E. C. 247715	
c.	729-II/IV Wr. Gap Shim.	E. C. 247592	
d.	Removable Armature Prolay	E. C. 247604	
e.	Ceramic Tension Adj.	E. C. 247594	
f.	Tape Cleaner Block	E. C. 247726	
g.	Jitter Brake	E. C. 247714	
h.	Prolay Lubrication	E. C. 247611	A. S. #14
i.	Vac. Col. Deburring	Mfg. Eng. Routing	
j.	Check and Align Transport Elements	Mfg. Eng. Routing	

2. Electrical

a.	11 ECR's	E. C. 246407
b.	Gnd. D. C. Reset of Wr. Trig.	E. C. 247124
c.	729-II Pre-amp Bank Pass Reduction	E. C. 247728
d.	Load Point Relay Ckt.	
e.	Integrator Relay Point Shot and DP-7 R.C.	E. C. 247723

System Changes (TAU)

a.	7070 Rd. Clip Level and Skew Gate - Slide TAU	E. C. 247829
b.	1401 Rd. Clip Level and Freeze	E. C. 247955
c.	1401 Skew Gate	E. C. 247956
d.	7090 Rd. Clip Level and Skew Gate - Slide TAU	E. C. _____